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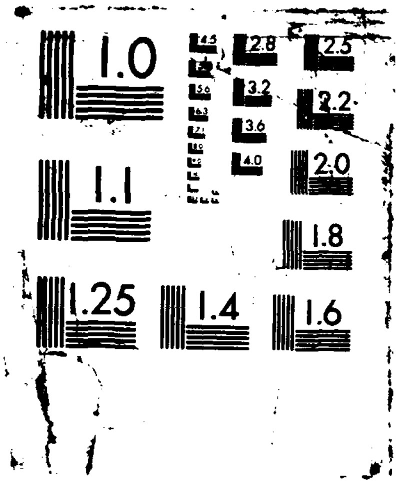
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# Fighting by the Numbers:
# The Role of Quantification in Tactical Decision Making

by

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By Major David A. Fastabend, U.S. Army, 99 pages

Quantification in tactical decision making is the application of mathematical measurements and estimates to tactical consideration of time, space, and relative combat power. The United States and the Soviet Union are remarkably divergent in the application of tactical quantification. The Soviets exercise a rigorous troop control methodology based on extensive quantification. The U.S. approach is primarily intuitive with little quantitative foundation.

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The U.S. Army officer sees tactical decision making as an art rather than a science. In recent decades the United States has enjoyed a heritage of tactical decision making in a resource-rich environment in which intuitive errors were redeemed by overwhelming material superiority. Specific tactical quantification guidelines are not incorporated into doctrine; tactical quantification procedures are addressed in a limited academic environment but rarely practiced.

The Soviet Army officer sees tactical decision making as a science rather than an art. The early disasters of the Great Patriotic War have left an ineradicable legacy of scientific troop control and tactical quantification. Tactical quantification is one component of a scientific systems approach to tactical decision making that incorporates doctrine, procedure, equipment and training without sacrificing the human component of the commander's creativity.

The stark dichotomy in the U.S. and Soviet application of tactical quantification can be examined in its historical, theoretical, and doctrinal implications. The U.S. Army lacks a balanced appreciation for tactical quantification's role as a complement to intuitive judgment. The United States Army must develop a systems approach to tactical decision making that incorporates tactical quantification into a comprehensive framework of theory, doctrine, training, and force development.

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# ABSTRACT

**FIGHTING BY THE NUMBERS: THE ROLE OF QUANTIFICATION IN TACTICAL DECISION MAKING, by MAJ DAVID A. FASTABEND, USA, 99 pages**

Quantification in tactical decision making is the application of mathematical measurements and estimates to tactical considerations of time, space, and relative combat power. The United States and the Soviet Union are remarkably divergent in the application of tactical quantification. The Soviets exercise a rigorous troop control methodology based on extensive quantification. The US approach is primarily intuitive with little quantitative foundation.

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The Soviet Army officer sees ~~tactical decision making~~ as a science, rather than an art. The early disasters of the Great Patriotic War have left an ineradicable legacy of scientific troop control and tactical quantification. Tactical quantification is one component of a scientific systems approach to tactical decision making that incorporates doctrine, procedure, equipment and training without sacrificing the human component of the commander's creativity.

The stark dichotomy in the US and Soviet application of tactical quantification can be examined in its historical, theoretical, and doctrinal implications. The US Army lacks a balanced appreciation for tactical quantification's role as a complement to intuitive judgment. The United States Army must develop a systems approach to tactical decision making that incorporates tactical quantification into a comprehensive framework of theory, doctrine, training and force development.

TABLE OF CONTENTS

# I INTRODUCTION

History portrays the Great Captains as men of genius, but what was the nature of that genius? Napoleon, for example, reputedly possessed "fertile imagination ... intuitive sense ... indomitable will power ... firmness of soul"[1]. Napoleon himself, however, ascribed to a more mathematical definition of genius:

> Nothing is attained in war except by calculation[2]
>
> Military science consists in carefully estimating all the eventualities first, then in estimating exactly, almost mathematically, the degree of chance. It is on this point that you must make no mistake, for a decimal more or less can change everything.[3]

Tactical genius: art or science? The tension between the intuitive requirements of tactical art and the quantitative considerations of tactical science presents a quandary for US Army tactical decision making doctrine and procedure. This quandary is nowhere more evident than in the US approach to tactical quantification.

Tactical quantification is the application of mathematical measurements and estimates to tactical considerations of time, space, and relative combat power. Tactical quantification has gained particular significance in light of the tremendous divergence of the tactical decision making approaches of the United States and the Soviet Union. The Soviets exercise a rigorous troop control methodology based on extensive quantification. The US approach is primarily intuitive with little quantitative foundation. This stark dichotomy in troop control processes constitutes a doctrinal "wager" in which the two superpowers are gambling the very foundations of their ability to wage war. The relative merits of that wager will be the subject of this analysis.

This analysis will address tactical decision making for ground forces at or below US Corps or Soviet Army level . The focus will be the quantification of time, space, and relative combat power considerations in the course of action development and analysis portions of the Estimate of the Situation. After examining the nature of tactical decision making on the modern battlefield, the study will compare and contrast the US approach to tactical quantification with that of the Soviet Union. This comparison will generate historical, theoretical and doctrinal implications for the validity of the US approach. Some projections for the future application of tactical quantification will conclude the analysis.

## II Decision Making on the Modern Battlefield

### The Nature of Battle: Danger, Exertion, Uncertainty and Chance

Notwithstanding the significant technological advances of the past decades, battle has retained those characteristics Clausewitz described as "the climate of war: *danger*, *exertion*, *uncertainty* and *chance*."[4] In the *danger* of battle, "..the light of reason is refracted in a manner quite different from that which is normal in academic speculation. It is an exceptional man who keeps his powers of quick decision intact..."[5]. *Exertion* (and violence - - danger's physical manifestation) further influence the commander's decision making process. That influence is both direct - - through exhaustion, suffering, or physical destruction of the commander - - and indirect - - through the commander's awareness of the destruction and suffering his subordinates. Clausewitz explained how the challenges of danger and exertion are compounded by the *uncertainty* of information: "Many intelligence reports in war are contradictory; even more are false, and most are uncertain"[6]. Even perfect intelligence cannot solve this dilemma; for besides the unknown there is also the unforeseeable: *chance*, according to Clausewitz, is "the very last thing that war lacks", so that "guesswork and luck come to play a great part in war."[7] Danger, exertion, uncertainty and chance are the principal components of the friction of war.

### The Evolution of Battle:

Friction has not merely survived the rigors of battle's technological evolution: it thrives in the modern battlefield environment. The increased lethality of current weapon systems extends both the magnitude and scope of battlefield danger and violence. Modern ranges and speeds have accelerated battle tempo, exacerbating uncertainty and amplifying the penalty for faulty decisions. Although modern intelligence systems may reduce the unknown somewhat, the expansion of an opponent's means and potential options has more than offset this progress by increasing the unforeseeable. The development of multiple combat means has introduced a level of battle complexity unknown in Clausewitz's time. Napoleon had a thorough knowledge of his primary combat resources: infantry, artillery and cavalry. In "carefully estimating all the eventualities", Napoleon did not wrestle with the chemical, biological, and radiological (CBR) environment, the full range of the electromagnetic spectrum, TACAIR apportionment/allocation, unit maneuver in three dimensions, or the command and control of subunits whose organization he did not understand through personal experience.

**Modern Tactical Decision Making: Friction vs Control**

The modern battle decision maker experiences a level of friendly "institutional uncertainty" previously associated only with enemy units. He must deal with a bewildering array of systems which influence the battle with unprecedented lethality and speed. In a world of tactical nuclear weapons, moreover, the consequences of incorrect or slow decision making are catastrophic. Modern combat organizations demonstrate a complexity and lethality that demand efficient application and measured control. The tension between this amplified friction and the increasingly critical imperative of battle control generates a certain ambiguity in the role of tactical quantification on the modern battlefield. That ambiguity is demonstrated in the remarkably divergent approaches to tactical quantification in the United States and the Soviet Union.

## III The US Application of Tactical Quantification

### Philosophy/Ideology

Although the scientific method of hypothesis and observation through empirical measurement is an important aspect of the Western intellectual tradition, its application is not universal in Western society. Westerners are particularly reluctant to apply the scientific method to many social processes because they are not readily susceptible to conclusive empirical measurement. This perspective has particular significance for military decision making:

> In Western thought, where science leaves off, intuition takes over. Because armed combat is a social process, the sizing up of military situations is largely left to the intuition of the individual decision maker. What is more, he need not justify his decision by quantitative means to anyone.[8]

To a Westerner, war is generally an unfathomable art that admits of no single 'best solution.'

### History of the Decision Process Development

**Origins of the Estimate of the Situation:** The concept of war as an art rather than a science was dominant in the United States until the turn of the century. At that time the Army sought to join the general societal trend to professionalism by developing a codified body of scientific military knowledge. Leavenworth's experimentation with the German Kriegspiel "applicatory system" was followed by Major Eben Swift's 1906 booklet on Field Orders, Messages and Reports and Captain Roger S. Fitch's 1909 Estimating Tactical Situations and Publishing Field Orders. Incorporation of the latter document into the 1910 Army Field Service Regulation essentially codified the US Army's current decision making process, "The Estimate of the Situation."[9]

It is interesting to note that these attempts to standardize military decision making were never an attempt to mass-produce genius. General Tasker H. Bliss introduced a 1911-12 Army War College Course of Instruction with the statement:

> It is not claimed that this method develops genius or brilliancy. It may even be discouraging to an officer who imagines that the daring and unerring combinations of a Napoleon are now as possible as ever.
>
> The object is to develop a school of safe leadership for officers and not to encourage unusual and extraordinary methods. We need fear little from the brilliancy of our enemies if we succeed in this. [10]

The Estimate of the Situation assumed enemy behavior that corresponds to his potential capabilities rather than his actual intentions, resulting in a conservative (safe-sided) estimate of military requirements.[11] Course of action development and analysis should include "calculations", but no rigorous mathematical methods were mandated. It was ideal for an emerging power with overwhelming material superiority and minimal external military threat.

**War Experiences**: The conservative potential for The Estimate of the Situation described by General Bliss appears to have been borne out by US experience in the wars of this century. US warfighting has generally been characterized by "an expectation of abundant material resources, the availability of superior firepower, and a tendency toward strategies of attrition".[12] Americans could afford an intuitive tactical decision making process, for intuitive errors were counterbalanced by abundant material resources. When the US has fought without overwhelming superiority in combat resources, results have frequently been disastrous. At the conclusion of the 1944 pursuit across France, US forces launched a series of attacks against the Siegfried Line fortifications at the western borders of Germany. Buoyed by recent success, these attacks frequently ignored quantitative indicators of relative combat power. In November of 1944, for example, the 28th Infantry Division's attack on Schmidt in the Huertgen Forest was launched with a relative strength ratio of 1:1 in personnel. Although a key component of the concept of the operation was the neutralization of enemy observation from the Brandenburg Ridge with artillery fire, the attack was launched with a 17:14 disadvantage in German vs US artillery battalions. Faulty calculation - - or the absence of calculation - - contributed to the destruction of the 28th ID in this attack.[13]

Because of widespread post-war fascination with German tactical success in WWII, the German war experience has become a part of our own military heritage.[14] To fully appreciate the impact of war experience on current US attitudes toward tactical quantification, one should examine not only the American experience but also the German one.

Although German WWII troop leading procedures were methodical, that methodology incorporated relatively little tactical quantification. The introduction to the pre-war German operations manual Truppenfuehrung noted that:

> Situations in war are of unlimited variety. They change often and suddenly and only rarely are from the first discernible. Incalculable elements are often of very great influence..[15]

In a post-war analysis (The Command Decision) Generaloberst Rendulic noted that the pre-war Truppenfuehrung was a broad directive containing only one definite numerical value - - division attack and defend frontages - - a value that proved to be grossly in error during operations on the Eastern Front. Noting that this inconsistency caused great consternation for some German officers, Rendulic concluded that there was great danger in including quantitative guidance in a service regulation. Rather, he said,

> ..a decision is not a problem of simple arithmetic, but a creative act .... intuition and keen sense of perception play a considerable role ... a decision must be reached, even if it is fully realized that it will be but a shot in the dark..[16]

The values Rendulic recommended in a commander included "... spiritual power, strength of character, maturity of mind ... personal experience ... a cool head and aggressive spirit."[17]

## Recent Experiences and Decision Process Evolution

**Post World War II Trends:** The emergence of nuclear weapons together with the acceptance of global responsibilities at the end of World War II exercised a centralizing tendency on American military decision making.[18] Simultaneous development of Operations Research, Systems Analysis techniques and rapid progress in computerization reinforced that trend. The trend was institutionalized during Robert McNamara's tenure as Secretary of Defense.

As the Army entered a period of reassessment at the conclusion of the Vietnam War, it changed its focus to Europe and a new doctrine: Active Defense. One unique feature of this doctrine was an emphasis on tactical quantification. Active Defense planning featured "battle calculus" with exhaustive analysis of relative combat ratios, optimum firing ranges, and "target servicing"[19] (Extracts from a typical battle calculus methodology are at Appendix A). During this same period there were concurrent efforts on a Tactical Operations System (TOS) which envisioned intensive automated quantitative analysis "to increase significantly the capability of Army combat division and subordinate commanders to manage the employment of combat power"[20].

Reaction: Centralization, McNamara's management techniques, and "battle calculus" did not prove to be the watershed of a flood of quantitative analysis in US tactical thinking. Powerful countercurrents were at work. The post-war trends toward centralization and scientific management techniques coincided with a series of failures in national policy and military endeavor. Debates ensued over the merits of such techniques for warfighting: should military men be "managers" or "leaders", "bean-counters" or "warriors"? Uneasiness with the "mechanistic approach that discounted all too easily the human element and the moral dimension of battle" was one reason for the rapid demise of the Active Defense doctrine.[21]

## Current US Practice, Tactical Quantification

The Western perception of tactical genius as an art, together with the limited acceptance of attempts to apply methodology to the decision making process, is reflected in current US tactical quantification practice with respect to doctrine, training, research and field application.

**Doctrine**: Current US Army doctrine recognizes the role of command and control in overcoming battlefield friction. FM 100-5, Operations, states:

> ..both leaders and units must be agile. Friction - the accumulation of chance errors, unexpected difficulties, and the confusion of battle - will impede both sides. To overcome it, leaders must continuously "read the battlefield," decide quickly, and act without hesitation.[22]

FM 101-5, Staff Organization and Operations, outlines the military decision making process, The Estimate of the Situation (FIG 1). The quantitative calculations that occur during that process are limited to the supporting functional area estimates such as intelligence, engineering and logistics.

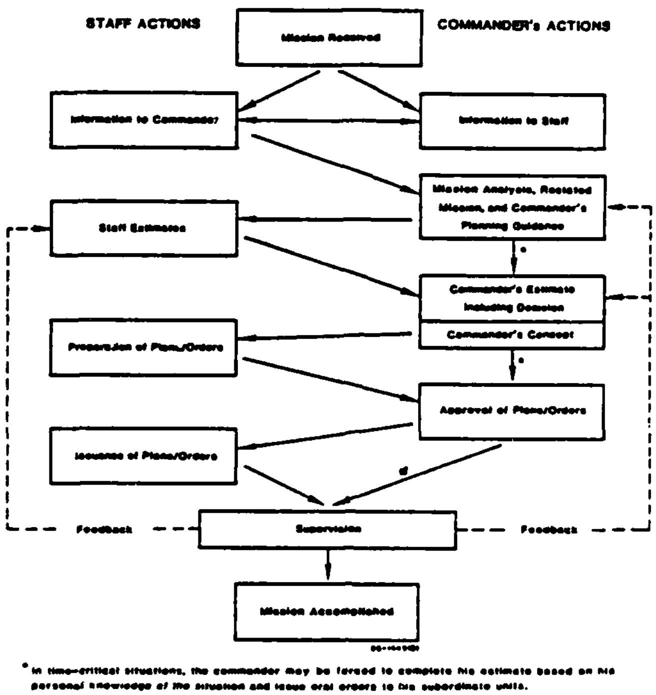



FIG 1 (from US Army FC 101-5-2, p 2-2)

The Commander's Estimate (Including Decision) is outlined in Appendix E to FM 101-5 (FIG 2).[23]

## COMMANDER'S ESTIMATE OF SITUATION

1. MISSION
2. THE SITUATION AND COURSE OF ACTION
3. ANALYSIS OF COURSES OF ACTION
4. COMPARISON OF COURSES OF ACTION
5. DECISION (RECOMMENDATION)

FIG 2

FC 101-55, Corps and Division Command and Control, acknowledges a distinction between intuitive course of action *concepts* and rational tactical plans.[24] Neither document suggests a quantitative procedure that effects the transition from intuitive concept to rational, substantiated plan. FC 101-5-2, Staff Officers Handbook, and FM 101-10-1, Staff Officer's Field Manual, Organizational, Technical and Logistic Data (Unclassified Data), offer many quantitative facts for logistic and intelligence estimation. This information, however, is only reference data for supporting analysis functions; there is no methodology for quantitative analysis in the core tactical decision making processes of course of action development and analysis.

**Training:** The US Army's written guidance on tactical quantification is the US Army Command and General Staff College Student Text 100-9, The Command Estimate. Although not doctrine, ST 100-9 offers a procedure for quantitative evaluation of combat ratios and relative movement rates. ST 100-9 qualifies the numerical basis of its estimates of relative combat power (FIG 1, Appendix B) as being "subjective" and cautions that an actual comparison should be based on "the current intelligence available and experience."[25] Application of the procedures in ST 100-9 is generally restricted to the school environment; students find the procedures tedious and difficult to apply in the rapid tempo of actual Tactical Operations Center (TOC) operations. Emphasis on tactical quantification in tactical analysis has steadily declined since its zenith in the Active Defense years.[26]

**Research:** Considerable quantitative analysis of tactical action is exercised in the research community through wargaming and simulations.

Dupuy's Quantitative Judgment Model (QJM) is based on analysis of historical data and is the foundation for a portion of the ST 100-9 calculations; Weapons Effectiveness Index/Weapons Unit Value (WEI/WUV) attrition coefficients are used in the Lanchestrian formulations of the McClintic Theater Model.[27] Quantitative tactical modeling is the foundation for several training tools such as Firefight (company team battle simulation) and TACOPS (Corps/Division simulation).

**Application:** Direct application of tactical quantification to the core Command Estimate processes of course of action development, analysis and comparison is rudimentary. Examples of the limited tactical quantification methodology offered by ST 100-9 are at Appendix B. US Army officers rarely apply either the quantitative analyses of ST 100-9 or the exhaustive subjective deliberations of FM 101-5's Appendix E. These methods are tedious and do not meet the requirements of modern battle tempo. The reality of current US tactical decision making practice is that course of action development and analysis is primarily an intuitive process.

US Army tactical plans frequently lack an effective fusion of objective considerations of space, time, and relative combat power. They typically focus on terrain and space, applying great emphasis to the clarity and coordination of graphic control measures. A US tactical planner will usually only coordinate time with respect to mission start, omitting any forecast of mission phase duration or completion time. He assesses the feasibility of tactical movement rates and times by "gut feel". Relative combat power is similarly an intuitive judgment. There is no attempt to quantitatively relate relative combat power to a forecast of movement through space over time. Although quantitative techniques such as target value analysis or the J-MEMMS tables may be used in fire support execution, they are not applied during the planning process of course of action development and analysis.

**Summary:**

Tactical quantification in the key decision process of course of action development and analysis is not incorporated into US doctrine or applied in field execution. "Number crunching" is accepted in research activities, battle simulations or the technical specialties of intelligence, fire support execution, engineering and logistics. With respect to tactical creativity and judgment, however, the average Army officer of the 1980's is more likely to believe that Airland Battle demands "holistic and intuitive thinking"[20]. He prefers the label "leader" over "manager", and is reluctant to be perceived as a "bean counter" rather than a "warrior".

## IV The Soviet Application of Quantification in Tactical Decision Making

### Philosophy/Ideology

Soviet officers approach the subject of troop control within the context of the Marxist-Leninist philosophy. Although a Soviet would agree with his US counterpart that war is a social process, he further believes that social processes are especially subject to "scientific determinism."[29] The Soviet officer deplores "subjectivism"[30] and "relativism" in the "science of war". He does not hesitate to apply methods of quantitative analysis to every aspect of tactical decision making. For a Soviet, "there is no such thing as a 'forbidden zone' of nonquantifiable factors."[31]

The Soviets maintain that there is an objective "best" solution to every military problem:

> Although many decisions are possible only one of them is appropriate and correct for a given situation. The other decisions are incorrect, or may result in only incomplete or partial success.[32]

Although a Western planner resigns himself to the unexpected and uncontrollable in military actions, his Soviet counterpart exercises a philosophy of secular determinism which holds chance to be "a refuge for the lazy-minded."[33] Soviets exercise a systems approach to troop control, incorporating troop control procedures into an integrated man-machine system of staffs, control posts, tactical communications, and automated systems and equipment.[34]

### History of the Decision Process Development

**War Experiences:** The current system of Soviet troop control had its origins in the Great Patriotic War with Nazi Germany. The Soviets were severely shaken by that war's initial tactical disasters - - disasters that they saw as failures of troop control. Early war deficiencies included vulnerability to German counter-control measures and an absence of standardized internal operating procedures for field staffs. The early war year experiences precipitated an emphasis on well-defined standardized procedures and staff activity norms that persists to this day.[35]

The command and control deficiencies of the initial war period were gradually corrected. Portugal'skiy notes in Command Procedures in World War II that as operations with larger mechanized forces were attempted, planning periods rose, orders and reports became more detailed, commanders attempted to exercise increased personal contact, and every possible technical means was applied to the troop control process.[36] By war's end the Germans themselves gave grudging respect to the Soviet skill in planning and preparing for operations.[37]

A common Western perception is that the Soviet tactical successes of the final war period were the inevitable result of overwhelming Soviet advantages in men and equipment. It is generally overlooked that Soviet advantages at Stalingrad were 1.1:1 and never exceeded 2.2:1 overall even in the final war period. The Soviets achieved crushing local superiority through brilliant deception and rapid concentration in areas of German weakness.[38] Careful analysis and efficient application of available resources were the foundation for the crushing local superiority that defeated the Germans in the final war period.

## Recent Experiences and Decision Process Evolution

**The Revolution in Military Affairs:** Since the early 1950s the Soviets have assessed the advent of nuclear weapons and other technological developments and concluded that a "Revolution in Military Affairs" is at hand. That revolution includes weaponry improvements such as thermonuclear devices, improved delivery means for combat systems, increased weapon saturation and combat capabilities, and the increased significance of the time factor in combat. The current stage of the "Revolution in Military Affairs" is the requirement for increased troop control effectiveness - the "management stage."[39] The Soviets have concluded that one consequence of these trends is an increasing importance in the analytical soundness of combat decisions.[40]

**Post-WWII Trends**: The Soviet recognition of the Revolution in Military Affairs coincided with the initial development of Operations Research, Systems Analysis techniques in the United States. The Soviets quickly seized on these techniques as potential solutions to the troop control problems of modern warfare. Mathematical optimization and the Program Evaluation and Review Technique (PERT) are representative of the quantitative tools applied to the tactical decision making process.[41]

Initial Soviet tactical quantification efforts indicated a mechanistic approach that hoped to reduce combat decision making to rigorous information processing - - a mathematical procedure. This original direction was abandoned in favor of a focus on the thinking process of the commander and his staff. Soviet writings were careful to emphasize the primacy of the human element in the decision making process.[42] Particular emphasis was applied to the fine-tuning of the man-machine interface between the tactical decision maker and the entire range of decision aids. Tactical quantification gained its current role as a tool for substantiation of the commander's decision rather than as a source for it.[43]

As appropriate technical means became available to the Soviet planner, he applied those means to the automation of troop control calculations. Conversion of tactical formulas to nomographs and calculation forms was soon followed by electronic calculators, programmable calculators, and computers. Although fielding of computers began at the higher headquarters, automated decision aids gradually migrated to the lower levels.[44]

These efforts were accompanied by a parallel revision of troop control procedures. In addressing the increased complexity of modern warfare, the Soviets made a conscious decision to seek more effective procedures and automation rather than larger staffs. The Soviets have also eliminated "pre-decision" staff conferences from their orders process; they believe these to be generally non-productive and not worth the heavy investment of that most precious combat resource: time.[45] The Soviets advocated parallel rather than sequential planning whenever possible, thus further compressing their decision cycle.

Current Soviet Practice, Tactical Quantification

The Soviet predisposition to "scientific determinism" and the recent history of their decision process development is evident in their current doctrine, training, and application of tactical quantification.

Doctrine: The Soviet concept of command and control is very different from our own. Control is seen primarily as a matter of information acquisition and analysis, rather than information acquisition and distribution. The command and control system is held to be the most potent weapon[46] available to the commander:

> In modern warfare the demands made on troop control have become even more strict. It (troop control) has now become a decisive

factor on a par with the number and quality of weapons, while the correlation of the levels of troop control is no less important than the correlation of weapons[47]

**Training**: Soviet officers slated for higher command spend more time in formal military training than their US counterparts.[47] Officers and commanders receive advanced training in mathematics and the use of decision aids. They achieve a great deal of facility and experience in the mechanics of effective staff action. Whereas a US officer would find many of the Soviet tactical nomographs intimidating, Vayner's standard text Tactical Calculations elucidates the principles of nomograph design and exhorts the Soviet officer to develop his own nomographs for the solution of routine tactical decision making problems.[49]

## Application

**The Soviet Troop Control Process**: The Soviet troop control process (FIG 3) differs from our own in the commander/staff interaction and in the application of tactical quantification.

## SOVIET TACTICAL PLANNING SEQUENCE

RECEIVE THE COMBAT MISSION

CLARIFY THE MISSION

ESTIMATE THE SITUATION

DEVELOP A CONCEPT OF OPERATION

ANALYZE THE CONCEPT OF OPERATION

MAKE AND FORMULATE THE DECISION

PLAN THE OPERATION

COMMUNICATE THE DECISION TO SUBORDINATES

FIG 3

**Role of the Commander**: The Soviet commander is not "supported by" the command and control system but instead is an integral part of it. The Soviet commander is not viewed as the final arbiter in the selection of courses of action developed by the staff.[50] The Soviet commander's role is more directly creative - - he develops a course of action, the staff subsequently checks it to insure that it is scientifically substantiated.[51] The commander is not only a leader but also the control system weapon operator who "...must be, first of all, a control engineer."[52]

**Quantification**: The Soviet staff accomplishes scientific substantiation of the commander's proposed course of action by subjecting it to extensive quantitative analysis. The course of action's feasibility is determined by comparing it to established norms for time, space, and relative combat power. The planning tools available to support the Soviet staff officer in this calculation effort include formulas, nomographs, calculation forms, programmable calculators and tactical computers. The mathematical techniques range from simple addition and subtraction to more sophisticated algorithms such as linear programming (LP) or the Program Review and Evaluation Technique (PERT). Some Soviet observers believe that higher level Soviet staffs employ extensive computer model simulation and wargaming to forecast the probable outcome of proposed courses of action.

**The Decision Support System**: The entire system of tactical calculation procedures, staff organizations, personnel and equipment comprise what the Soviets call their Decision Support System, or ASUV (*Automizirovanniye Sistemy Upravleniya Voyskami*). The four principal purposes of the ASUV are information storage and retrieval, tactical planning calculations, decision evaluation and transmission of commands.[53]

The ASUV is not a Soviet MCS (Maneuver Control System) but rather is a combination of both automated and non-automated procedures that reflects the Soviet systems approach to tactical decision making. The ASUV is a multi-echeloned series of man/machine systems tailored to the decision content and time requirements of each echelon. Calculations are less complex (yet more detailed) at the lower echelons. The ASUV is an integrated system in which staff devices support the quantitative analysis requirements of the staff procedures; personnel are trained in those procedures and apply them consistently throughout the force.

**The Quantification/Reconnaissance Dynamic:** The Soviet forces are famous for the vigor of their reconnaissance effort. This is driven by their tactical quantification methodology: the requirement for measurable estimates of enemy activity generates a relentless search for reconnaissance information that permeates the entire force.

**Tactical Calculations:** Soviet tactical calculations support course of action analysis in three ways. Direct calculations analyze a situation and estimate the results, e.g. - - the firing of three 152-mm batteries on a US infantry platoon defensive position will destroy 65% of that position. Inverse calculations determine the necessary inputs to produce a desired result, e.g. - - to produce 90% destruction of an enemy armor company at 1200 m range, 12 antitank guns must be employed. Whereas direct calculation answers the question "what are the possible ends given the available means," and inverse calculations indicate the necessary means to achieve a desired end, optimization calculations estimate the optimum tradeoff of ends and means to achieve the assigned mission. An example optimization calculation might be determination of the optimum distribution of limited available artillery fires on identified enemy defensive positions.[55] Direct, inverse, and optimization calculations are applied to tactical considerations of time, space, and relative combat power.

<u>Time - The Diagrammatic Planning Process</u>: The Soviet application of the PERT method to depict the time relationships of combat activities has no US counterpart. FIG 4 is a representative PERT diagram depicting the preparation of a tank battalion for an attack.

NETWORK SCHEDULE OF READYING TANK BATTALION FOR ATTACK

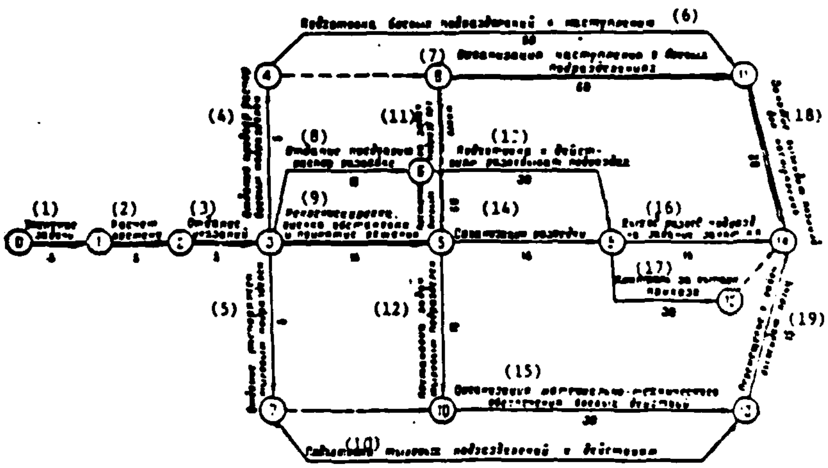


**Figure 33. Network Schedule of Readying Tank Battalion for Attack (example)**

**Key:**

1. Mission briefing
2. Time calculation
3. Issuing instructions
4. Issuing warning order to combat subunits
5. Issuing warning order to rear services subunit
6. Readying combat subunits for attack
7. Organization for attack in combat subunits
8. Issuing warning order to reconnaissance
9. Commander's reconnaissance, situation estimate, and decision-making
10. Readying rear services subunits for action
11. Allocation of tasks to combat subunits
12. Allocation of tasks to rear services subunits
13. Readying reconnaissance subunits for action
14. Organization of reconnaissance
15. Organization of combat service support
16. Reconnaissance subunits proceed to execute mission, establish observation posts
17. Verification of execution of order
18. Occupy assembly area for offensive operation
19. Movement to assembly area

FIG 4

The Soviets routinely apply the PERT method, referencing the diagrammatic planning process in discussions of everything from communication antenna erection to multi-front offensives.[56] The Soviets do not depend on automation for application of PERT, and state that manual computation is generally more efficient for tactical networks.[57] PERT is applied not only to the tactical decision making process, but also to the subsequent troop control procedures of organizing and monitoring the execution of the decision.[58] The PERT method becomes a vital link between the planning and the execution process that allows the Soviet commander to rapidly shift the phasing of combat activities to account for unexpected successes and failures in tactical execution.

**Space - Movement Planning**: The Soviet evaluation of space seldom occurs without simultaneous consideration of time: movement calculations are an essential component of their tactical analysis. Of the 43 tactical calculation examples listed in Vayner's Tactical Calculations, fully 23 are associated with movement planning.[59] The careful estimation of movement times (and space requirements) serves as input to individual components of the PERT diagrammatic combat model.

Relative Combat Power - the Correlation of Forces: The Soviet estimate of relative combat power is more than a numerical accounting of the quantity of combat resources available to each side. Considerable effort is made to account for the relative quality of opposing weapon systems by converting weapon system quantities to standard units of armament (SUAs). The qualitative value of opposing weapon systems are then employed to develop multiple indices of relative combat power in the categories personnel, tanks, armored personnel carriers, artillery and mortars, antitank weapons, antiaircraft defenses, and aircraft.[60] In developing an adequate correlation of forces, the Soviet planner relies heavily on supporting artillery fires. Unlike the US planner, whose primary course of action artillery decision is the task organization of available artillery assets, the Soviet planner uses calculation aids such as the nomograph at FIG 5 to substantiate the adequacy of scheduled fire support.

**NOMOGRAM EMPLOYED TO DETERMINE EFFECTIVENESS OF ARTILLERY BARRAGES (U)**

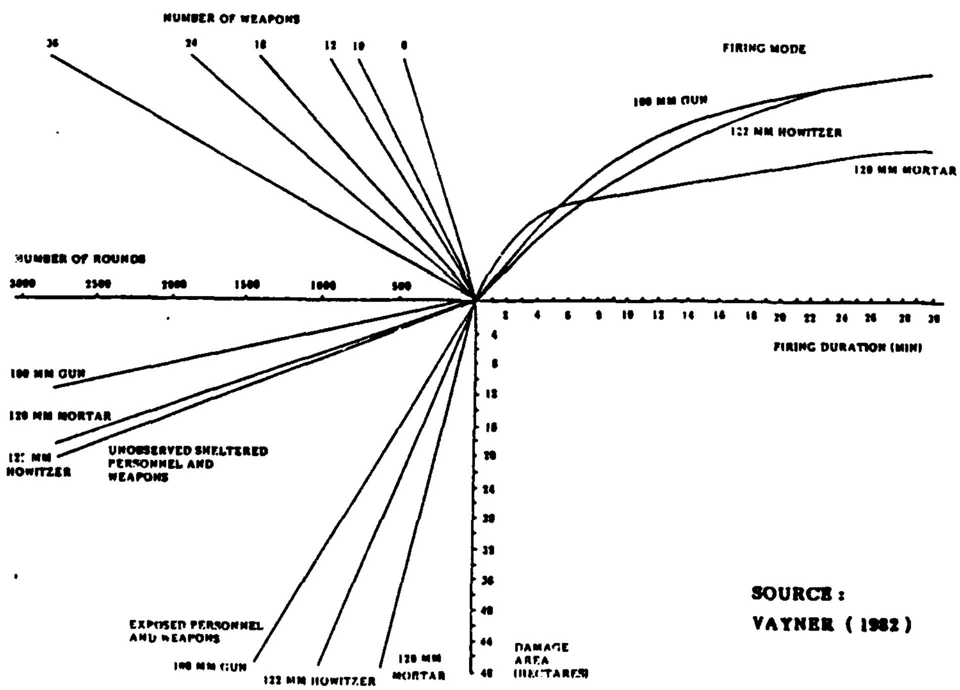



FIG 5

<u>Fusion</u>: The Soviets achieve a fusion of their time, space, and relative combat power calculations through a series of nomograms that portray the estimated relationships of these combat factors. (Example

nomograms are at Appendix C, Representative Tactical Quantification, Soviet.) These nomograms are based on Lanchester-style combat models that are simple and approximate, but nevertheless serve to mark the probable bounds of feasible combat.[61] They stand in marked contrast to the US Army ST 100-9, that maintains, "There is no direct relationship between force ratios and attrition or rates of advance."[62]

**Summary**:

Whereas the US officer perceives the Soviet system of troop control to be rigid and over-centralized, the Soviet probably views his uniform methodology and scientific substantiation of tactical decisions as a decentralizing influence that promotes unity of effort even in the absence of positive control. If a US tactical planner questioned the use of computers and information-intensive combat models for tactical planning, the Soviet would cite the approximate nature of those models and their role as a complement to military judgment rather than a substitute for it. Although we associate quantification in tactical decision making with a limitation of the commander's prerogatives that leads to predictability, the Soviets believe that creativity is maintained in the Commander's development of the tactical concept, and that quantification reinforces that creativity by providing an objective feedback estimate of the projected results of his creative decision. Unconcerned that tactical unit activities may be over-constrained, the Soviets are satisfied that tactical predictability leads to operational-level success.[63]

## V Implications of the Soviet/US Dichotomy in Tactical Decision Making

The stark dichotomy between the US and the Soviet concepts of troop control reveals historical, theoretical and doctrinal implications for the soundness of the US approach to tactical quantification.

### Historical Implications

**The Estimate of the Situation:** The US Army's general historical trend of tactical success has given the Estimate of the Situation an aura of legitimacy that may be exaggerated. The Estimate's origin as a conservative planning tool is significant in light of America's current resource posture. The Estimate served the US military professional well during the decades of preponderant military advantage. Overwhelming material superiority compensated for the inefficiencies of intuitive decision making. But can the US afford an intuitive tactical planning method in a resource-poor environment? Scarce resources require that our future tactical genius incorporate military efficiency, not sacrifice it.

**Misapplication of the German Experience:** The German WWII propensity to dispense with mathematical tactical models and rely on "spiritual power" and "aggressive spirit" has exacerbated the American reluctance to apply tactical quantification. One can not help but believe that if the German practice had included the Russian normative approach to tactical decision making, every American combat arms officer would have a calculator on his web belt. The German WWII experience, however, does not conclusively demonstrate the inadvisability of tactical quantification. It is noteworthy that the remarkable German successes of the early war years were against an opponent not yet employing the techniques of modern cybernetic theory. Martin Van Creveld acknowledges that the conditions of Germany's tactical achievements are not completely applicable to the modern context:

> ...the mere fact that a present day Bundeswehr division contains 900 different MOS, as against only 40 in World War II, is itself sufficient to turn the Wehrmacht's entire loose and decentralized personnel management system into a historical curiosity[64]

If we are to achieve an American Auftragstaktik, we can not simply co-opt a phrase and with it gain the fruits of decades of German tactical innovation, doctrinal development and training. An American Auftragstaktik will require a similar investment to establish a common cultural bias of doctrinal terms, tactical procedures, and a combined arms organization that facilitates decentralized combat operations. Tactical quantification can accelerate that process by providing a rigorous frame of reference for the examination of tactical problems and the comparison of tactical solutions through specific numerical estimates of time, space, and relative combat power. An Army that is practically mute in the language of operational terms may well start with the unambiguous language of numbers as the initial foundation for a common cultural bias.

**The Legacy of the Active Defense**: The legacy of the mechanistic battle calculus of the Active Defense is anything but quantitative. In the Army's justified enthusiasm to reject the excessive defensive focus of that doctrine, it may have inadvertently associated the mechanics of the doctrine - - quantification - - with the deficiencies of the Active Defense. All tactics must be based on - - among other things - - certain objective considerations of time, space, and relative combat power. The flaw in Active Defense was not tactical quantification but a reactive focus that failed to account for the depth of opposing forces.[65]

The European focus was another aspect of the Active Defense that led to a decline in US Army tactical quantification. The General Defense Plan focus undermined one of the oldest components of our Army's tactical quantification skills - - large scale movement planning:

> Offensive doctrine was a dead letter in the Army for many years....the modest requirements of our earlier defensive doctrine allowed tacticians to forget about movement once units reached their sectors.[66]

Moreover, the Active Defense coincided with a renewed and detailed look at our European opponents - - the Soviets. This look presented a frightening view of an opponent that had methodically modernized and expanded its forces while the United States fought a painful war in Southeast Asia. Some US thinkers seized on "initiative" and native intelligence as some sort of antidote for the overwhelming imbalance in relative combat power. A deprecation of Soviet decision making as rigid and non-creative supported this view. Although US perceptions of Soviet capabilities are now more realistic, many US officers still associate tactical quantification with imagined deficiencies in Soviet tactics.

**The Modern Battlefield:** Initial periods of combat may well be decisive in the next war. The United States no longer has the luxury of a prolonged period of intuitive tactical learning and experience generation. The projected tempo and expense of modern battle eliminate the prospect of experiential learning: there is no Italy where a budding Napoleon can gradually acquire war experience in tactical decision making. Troop control procedures will not have the time to evolve during combat: the initial command and control procedures may prove to be decisive.[67] We should carefully reexamine The Estimate to determine if a process and a format that has not changed fundamentally in several decades still meets the requirements of modern battle.

## Theoretical Implications

**Art vs Science; Difficulties vs Puzzles:** Writing in Background to Decision Making, William A. Reitzel provides an excellent framework for addressing the theoretical implications of the US/Soviet troop control dichotomy through his distinction between *puzzles* and *difficulties*:

> ... a fundamental source of confusion in ordinary talk about decision making ... concerns the difference between *performing calculations* (finding exact answers) and *making choices* (picking a course of action to gain an objective.) Consider two very plain English words in this connection: *Puzzle* and *Difficulty*.
>
> A *Puzzle* is an uncertainty that can usually be solved correctly in one way. It always has a solution and the solution is an absolute one..... A *difficulty* is another kind of uncertainty altogether. It cannot be solved in the preceding sense. It can be surmounted, overcome, reduced, avoided, ignored; but it cannot be solved.[68]

Reitzel goes on to point out that frequently military problems are difficulties that include solvable components - puzzles. Frequently puzzles and difficulties correspond to staff and command responsibilities in tactical decision making. Reitzel summarized that relationship as follows:

| | |
|---|---|
| The Puzzle responds to | The Difficulty responds to |
| Measurement | Analysis |
| Calculation | Professional Judgment |
| Staff Work | Choice of courses |
| and is | and is (sometimes with the aid of puzzle techniques) |
| SOLVABLE | SURMOUNTABLE[69] |

The implications of our failure to distinguish between puzzles and difficulties is evident in the theoretical considerations of Friction, Creativity, Centralization, and Command & Control.

**Tactical Quantification and Friction:** While danger, exertion, uncertainty and chance guarantee that every important tactical decision will be a serious *difficulty*, we must also realize that each *difficulty* includes several components that are in fact *puzzles*. It would be foolish to forego the solution of those few solvable *puzzles* of time, space, and relative combat power merely because ultimate elimination of the total tactical *difficulty* is beyond our ken. Tactical quantification provides an objective frame of reference that steadies the commander against the eroding influences of danger and exertion. Although uncertainty and chance are not amenable to exact measurement, even approximate measurement has its utility. A commander can not predict the exact outcome of a contemplated engagement, for example, but an analysis of relative unit capabilities may establish reasonable bounds on the probable result. An Army contemplating combat on the modern battlefield would be ill-advised to dispense with any tool that potentially reduces the *difficulty* of modern combat friction.

**Tactical Quantification and Creativity:** If tactical problems were mere *puzzles*, then tactical quantification might lead to mundane, stereotyped tactical solutions. Because tactical problems are *difficulties*, however, the application of quantification will not precipitate a routine, unimaginative solution. On the contrary, quantification can bolster the creativity of the tactical decision maker in two ways. First, automation of tactical quantification procedures can free the staff from routine, non-creative tasks. More importantly, no creativity is possible without some form of measured feedback. Nothing could be more stifling to creativity than an inability to forecast and estimate the results of projected courses of action. Quantification offers the measurement and comparison tools so integral to any creative process.

**Tactical Quantification and Centralization**: For many US Army officers the initial introduction of modern management methods coincided with the debut of expensive "central" computers. It is understandable that quantification techniques should be unfavorably associated with centralized management trends. The advent of inexpensive and effective microcomputers, however, has broken the bond between automation and centralization. Tactical quantification can now provide an unambiguous description of time, space and combat power requirements that supports a decentralization, rather than a centralization, of combat decision making.

**Control vs Command, Leadership vs Management**: The US Army must abandon the mindset that demands a choice between Command or Control, Leadership or Management. These concepts are complementary, not contradictory: "Command is the desired result and leadership is the primary means. Control is the adjunct to command and management is its means."[26] The negative association of quantification with "control" has caused many officers to ignore the potential of tactical quantification. If we are going to have an army in which officers train for both command and staff, then we should recognize that between those rare command opportunities for "intuitive coup d'oeil", most officers must frequently serve as astute staff "control engineers." Tactical quantification skills can serve them well in both roles.

## Doctrinal Implications

Although the professional soldier may be tempted to ignore the historical and theoretical implications of the divergent US and Soviet approaches to tactical quantification, the doctrinal implications of that dichotomy demand his attention. Steven Argersinger comments that:

> All else being equal, we would find it very difficult, if not impossible, to turn inside the Soviet decision (control) cycle based solely on staff mechanics[71]

The US approach to tactical quantification has important implications for the tenets of US Army Airland Battle doctrine: *Agility, Initiative, Depth* and *Synchronization*.

**Decision Making Agility**: It is essential to distinguish tactical decision making *agility* from *serendipity*. *Agility* is not the capacity for "intuitive and holistic thinking", nor does it connote a propensity to rapidly change one's mind. *Agility* in tactical decision making is our capacity - - relative to that of our opponent - - to acquire, analyze, and act on information. The increased complexity of modern combat has limited the *agility* potential of human intuition;[72] *agility* requires not only creativity but also less exciting yet essential expertise in staff mechanics and estimate quantification. So long as the outcome of combat depends on the relative combat power of forces moving in time and space, quantifiable estimates will have an indispensable role in tactical decision making *agility*.

**Decision Making Initiative**: The relationship of tactical quantification to decision making initiative originates in the feedback mechanism inherent to any decision process. To initiate action, the tactical decision maker must first identify the requirement for action. To identify that requirement, he must estimate the combat situation. That estimate is not only qualitative - - through our subjective assessment of the situation - - but also quantitative - - through objective measurements of space, time and relative combat power. Tactical quantification is a necessary component to accurate and timely estimation - - the feedback process essential to decision making *initiative*.

**Decision Making Depth:** The increased tempo and spatial *depth* of the modern battlefield generates requirements for a parallel decision making "*depth*". Enemy and friendly activities must be forecast and planned for longer periods and greater distances. This increased scope magnifies both the amount and the complexity of the data presented to the tactical planner.[73] It is no longer sufficient - - as FM 100-5 suggests - - merely to *read* the modern battlefield; the tactical planner must also *understand* it. Such understanding is not likely without the support of quantified estimates of time, space and relative combat power.

**Decision Making Synchronization:** Army officers are understandably wary of the Russian practice of scheduling combat activities. Combat according to detailed timetables evokes memory of the WWI Somme disaster in which hundreds of thousands went to their deaths in an orderly schedule. Again a key distinction is necessary in order to appreciate the proper role of tactical quantification: combat *synchronization* is not combat *scheduling*. Scheduling is the planning of subunit mission accomplishment with respect to absolute date-time groups. It is appropriate in planning as a subunit coordination measure. It is potentially disastrous as a mission execution control measure. *Synchronization* is the planning of subunit task accomplishments with respect to each other and to some unifying objective. It is not important that the 52d Mech Division attack at 1500 hours (as scheduled), for example, but it is important that this supporting attack coincide with the main Corps attack in an adjacent division sector. Quantified time estimates are necessary to forecast the relative synchronization of combat activities, not their absolute accomplishment in time. This relative coordination, plus the ability to rapidly adjust and manipulate those relationships during tactical execution, is the advantage the Soviets gain in their diagrammatic planning process.

**The Evaluation of Doctrine:** Tactical quantification has a role not only in the application of doctrine, but also in its evaluation. A careful quantitative analysis was instrumental in the decision to discard the Active Defense.[74] An inability to assess the validity of our fundamental doctrinal assumptions is the most frightening aspect of the Army's current neglect of tactical quantification. Our doctrine deserves the same rigorous examination that led to the demise of its predecessor. A frank examination of correlations of forces, movement rates and unit frontages may be a highly discomforting exercise. It is nevertheless a necessary one if our doctrine is to meet the needs of the national defense.

**Tactical Quantification: Foundation for the Operational Level of War:** The act of intuition incorporates past personal experience to evaluate the feasibility of intended courses of action. The dilemma is that as one ascends to the higher levels of command, the personal experience of the planner becomes relatively limited in supplying that intuitive appreciation. Most combat arms officers know the amount of time and space needed to deploy an armor company column into an attack formation, for example, but relatively few appreciate the routes, depth and time required for a division movement. Holger H. Herwig's observations on German military planning are interesting in this regard: a force noted for exemplary tactical proficiency failed because at higher levels an "ostrich like refusal to tackle the 'technical side' of the military plan guaranteed exhaustion rather than victory."[75] At higher levels, quantification is a necessary aid to fathom the myriad complexities of division/corps movement and logistic functions. Tactical quantification helps form the foundation for judgment at the operational level of war.

**A Caveat:**

Reitzel's caveat on the limitations of "puzzle-solving" is hardly necessary for an Army already wary of tactical quantification:

> ...the legitimate success of puzzle-solving responses can easily lead to their illegitimate extension to the genuinely non-measurable and non-calculable aspects of a difficulty. When an uncertainty situation involves human preferences, human values, and humanly defined objectives, it is more than a puzzle and it will never be effectively - that is, satisfactorily - overcome by dealing with it as if it were a puzzle.[76]

Nevertheless, Reitzel's concern is well taken: a simplistic application of tactical quantification can be disastrous. Estimation of relative combat power is never a simple accounting puzzle - Dupuy's analysis of 42 battles over the last two centuries indicates that in 24 (57%) of these battles the victor was numerically inferior.[77] Any estimate of relative combat power must address the entire spectrum of firepower, mobility, protection and leadership; it will always be a *difficulty* in which tactical quantification must complement intuitive judgment.

## VI Projections for the Application of Tactical Quantification

The persistence of the factors that precipitated the "Revolution in Military Affairs" will continue to give impetus to tactical quantification's role in the cybernetic domain of battle.

**Soviet Projections:**

Since *relative* agility is the key criteria for successful tactical decision making, Soviet projections are of especial interest. The Soviets do not consider their extensive progress in this field to be complete:

> ...perfection of troop control must be conducted constantly, for there is no limit to scientific-technical progress, raising of the combat capacities of armaments, military equipment, and groupings of troops (forces).[78]

Altukhov describes the principal requirements for future Soviet troop control to be improved operativeness (effectiveness), stability (continuity of operations), quality and secrecy. The Soviets see a premier role for computers in meeting their future cybernetic requirements.[79] The Soviets also have high regard for the potential of artificial intelligence technology. Frolov compares the current pessimism on artificial intelligence to the limitations of Newtonian mechanics before the discovery of quantum mechanics; artificial intelligence is seen as a further decision aid that will expand the commander's creativity.[80]

We can expect the Soviets to continue to field decision support systems that are completely integrated with their doctrine, training, and troop control procedures. As technical means are developed or obtained from the West, they will quickly apply them to tactical decision making problems. The field use of tactical computers will continue its migration to lower levels of command.

US Projections:

Any projections for future application of quantification in US tactical decision making must be carefully placed in their broader methodological context. Accurate force correlations, for example, are simple mathematical estimates, they are meaningless outside the framework of an effective estimate process. Quantification in tactical decision making is not a "problem" amenable to direct solution; it must be a component of a systematic approach to tactical decision making that incorporates theory, doctrine, training and force development.

**Theory**: Theory serves as a framework of organized knowledge. Although Soviet officers work within an extensive conceptual framework of "laws of warfare", "principles of military art", and "law-governed patterns", US thinking is less structured. A 1979 US colloquium on command and control systems concluded that "there is no adequate foundation for a theory of command and control and, hence, no guiding principle for system design and development."[61] Although the United States has generated some significant work on the theory of decision making in general, that theory has not been incorporated into military thinking. The development of a revised theoretical foundation for tactical decision making that incorporates some of the significant civilian advances in this field would be an excellent basis for further progress in this key area.

Beyond the theory of decision making, there is extensive theoretical work to be done with respect to the mechanics of tactical quantification. The scientific basis of the limited quantification guidelines in ST 100-9 is uncertain. The guidelines themselves are far from complete. What is the appropriate correlation factor between Soviet and US weapons and units?

What are reasonable movement rates for opposed and unopposed movement in different types of terrain? How long will certain key combat activities really take? Should relative combat power be evaluated by one overall index or by multiple indices? Are the Soviet Lanchestrian relationships of force correlations to attrition and movement correct? How can the IPB process drive a quantitative estimate of indirect fire support requirements? These are questions that the United States is relatively well-equipped to answer. But these questions will not be answered until they are asked.

Doctrine: The absence of an organized theory of tactical decision making is further reflected in doctrine - - the application of theory to current context. In light of the incredible evolution of modern combat means, the fact that our procedures and our format for tactical decision making have not changed significantly in several decades is reason enough for their serious reexamination. A fundamental objective of that reexamination should be to determine if those procedures meet the tempo and complexity challenges of modern tactical decision making.

An additional objective should be to determine if tactical quantification merits an outright position in US tactical decision making doctrine or should rather be described as a potential implementing procedure. The difficulties and delays associated with acceptance of doctrine in the US Army are well known. The current doctrine development process may be incapable of keeping pace with the changes in quantification techniques and tools. Conversely, the current relegation of the ST 100-9 quantification procedures to a restricted academic environment limits the understanding of those techniques, their implementation in the field, and the development of supporting procedures and equipment.

**Training:** FM 100-5 observes that :

> In the end, agility is as much a mental as a physical quality. Our Army has traditionally taken pride in its soldiers ability to "think on their feet" and to see and react rapidly to changing circumstances....[62]

Is "think on your feet" adequate guidance to prepare our soldiers for the complexity of decision making on the modern battlefield? The French after-action report describing the debacle of the 1940 Battle of France concluded that "future training exercises should emphasize having commanders solve unanticipated problems, make decisions, and issue orders rapidly."[63] Intuitive judgment - - through its reliance on previous experience - - can disastrously fail to meet the challenge of unexpected enemy combat methods. There is an obvious potential for tactical quantification as an analytical tool to supplement judgment in unique, unanticipated tactical situations.

That tool will be useless, however, unless officers are trained in its application. US Army officers are generally intelligent, industrious, and computer-literate. They have the maturity to exercise quantifiable decision making techniques with proper restraint and appreciation of the limitations of those techniques. The fundamentals of tactical quantification techniques should be a component of every officer's entry-level professional training.

**Force Development**: A major obstacle to implementation of tactical quantification in the United States Army is the tediousness and difficulty of manual calculation. A decision that is quantitatively substantiated is useless if it occurs too late. Tactical quantification and field automation devices have a reinforcing relationship: automation is not advantageous unless the decision process includes quantitative, algorithmic components; tactical quantification techniques are expedited by automated decision aids.

An absence of tactical quantification techniques is the origin of the US propensity to apply automation to data storage and communication rather than to analysis. The current projections for tactical decision making devices do not promise to reverse that trend. The Maneuver Control System is primarily a data acquisition, storage and retrieval system with limited capacity for data analysis.[84]

The development of quantifiable decision techniques is the fundamental, indispensable first step needed to capture the benefits of modern computers for the tactical decision making process. This is one of those rare situations in which equipment is not an obstacle - - most tactical quantification procedures are readily programmed on the type of personal computer now available in all headquarters. Inclosure D describes several automated decision aids to demonstrate the potential of the microcomputer to facilitate tactical quantification calculations.

## VII Conclusion and Summary

Tactical genius: art or science? Major E.S. Johnston addressed this question in his 1934 paper, A Science of War:

> The application of knowledge ... is *art*. All arts ... rest on science. War is both a science and an art; and, as for any art, we will apply it more effectively as an art if we understand the science underlying it.[85]

In assessing the merits of the superpowers' doctrinal "wager" - - the stark dichotomy in their troop control processes - - it would appear that the Soviets exercise a sounder approach to tactical quantification. The US assumption that tactical genius is a pure art may in fact be a reckless gamble. Although it is difficult to reconcile the clearly measurable tactical considerations of time, space, and relative combat power with the unquantifiable factors of danger, violence, uncertainty and chance, we can surely do better than to choose between them! A failure to acknowledge tactical quantification as a complement to intuitive judgment produces a self-imposed friction in which, as Napoleon stated, "an abundance of ideas without firm and rapid analysis blinds rather than clarifies."[86]

American officers are intelligent, computer-literate, and have the maturity to exercise appropriate restraint in the application of tactical quantification. It is ironic that the most technically developed nation in the world eschews quantification - - the language of technology - - in the planning of combat. When the United States Army restores balance to its appreciation of tactical quantification, US Army officers will be better prepared to meet B.H. Liddell Hart's prescription for tactical genius:

> Creative imagination is the essential characteristic of genius ... when coupled with dynamic energy, it produces an executive genius. When balanced by cool calculation, it makes a Great Captain.[87]

## APP A The Battle Calculus Method

Inclosures 1 through 3 are representative extracts from the BDM Corporation Commander's Battle Book with Battle Book Calculus. They are typical "battle calculus" methodologies that supported Active Defense tactical doctrine.

Inclosure 1 - Battle Book Calculus Method Overview

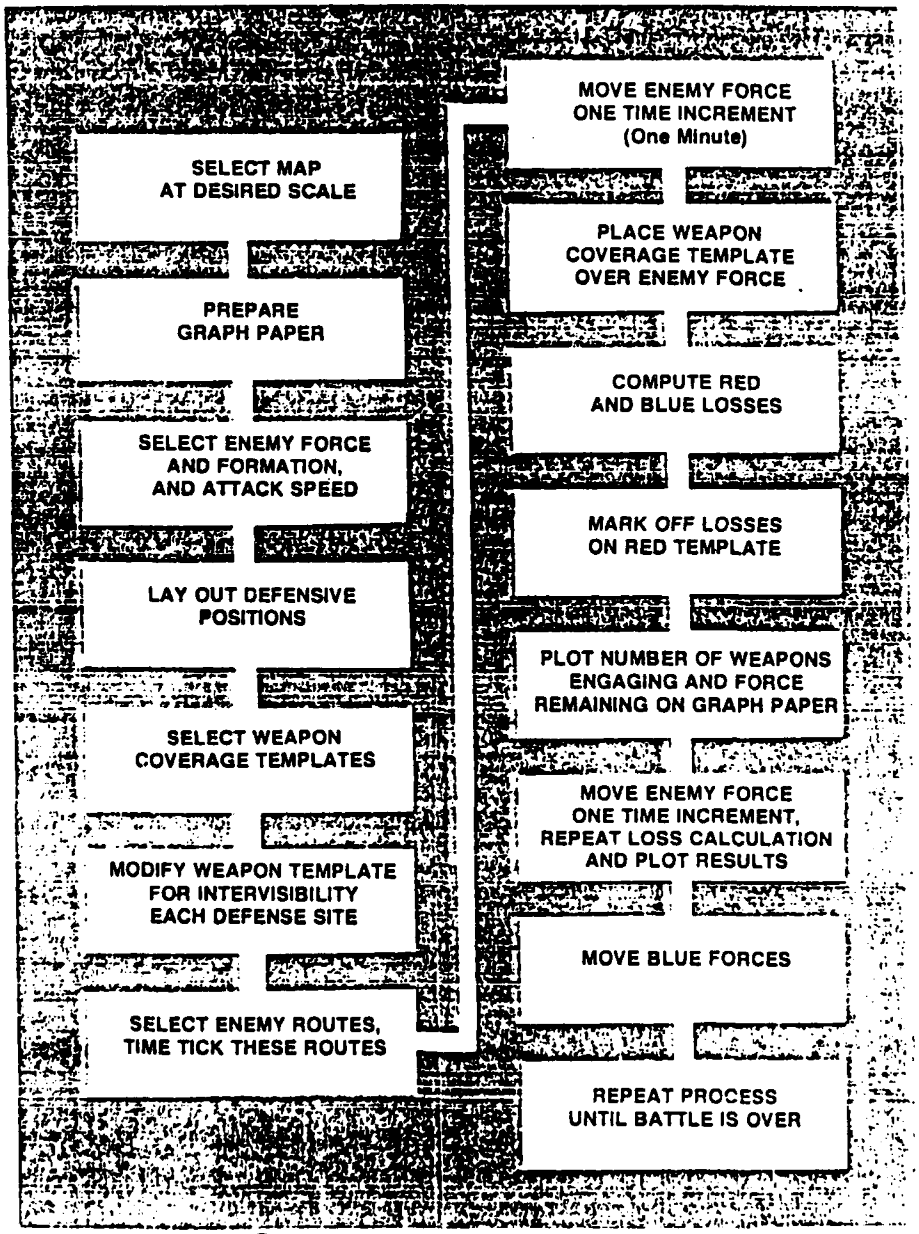
2 - Steps for Moving Forces and Calculating Engagements

3 - Loss Calculation Graphs (2 pages)

Inclosure 1, App A: Battle Book Calculus Method Overview

From: The BDM Corporation, Commander's Battle Book with Battle Book Calculus, (Fort Ord, California) (undated)






Overview of Battle Book Calculus Method

Inclosure 2, App A: Steps for Moving Forces and Calculating Engagements

From: The BDM Corporation, Commander's Battle Book with Battle Book Calculus, (Fort Ord, California) (undated)



## MOVING FORCES AND CALCULATING ENGAGEMENTS

**Now move forces minute-by-minute and use templates to determine forces engaged. Losses are calculated and a graph is built which illustrates Blue and Red force commitment and losses sustained.**

**STEP NO. 1** — Using Engineer graph paper or a suitable substitute, draw a vertical line along the left margin of the graph paper. One for the Red Force and one for the Blue as shown in the example. Next lay off in multiples of ten, a series of indices going from 0 to whatever number comprises the total Red and/or Blue forces. These will be used to indicate the total weapons engaged, and force remaining in the battle, for each minute of play.

**STEP NO. 2** — Draw a horizontal line from the base of the vertical line drawn, extending it to the right. Along this line lay off in equal parts a series of indices indicating separate one-minute intervals of battle time.

**STEP NO. 3** — Move the Red force at one minute intervals until forces engage. Using the Red unit templates and the Blue weapon coverage templates determine the Red and Blue units engaged. At the top of the Red and Blue battle graphs, record for each minute of the battle, the identity of the units engaged by battalion and company for the Red force and by weapon position for the Blue force. Indicate opposite each unit/position, the total weapons, by type, engaged during that minute of the battle.* Then add together the total number of weapons engaged. *For the example, in the first minute there are 16 Red and 19 Blue weapons engaged. For the second minute the total is 37 Red and 21 Blue weapons engaged. The numbers for the second minute reflect the addition of weapons due to new Red weapons advancing within Blue weapon coverage. In the case of Red weapons, the loss of five weapons due to Blue action in the previous minute is also reflected.*

**STEP NO. 4** — (Optional) Beneath each of the Red and Blue bar graphs record the cumulative number of weapons committed as the battle progresses. This can be done by keeping a scratch sheet total, adding to it the number of new weapons which become engaged as the Red force advances. *In the example, this is 16 Red and 19 Blue for the first minute interval, and increases to 42 Red and 21 Blue for the second minute. Cumulative losses are also shown here, five for Red and none for Blue at the end of the first minute, and ten for Red and one for Blue at the end of the second minute (losses calculated in Step No. 5).*

**STEP NO. 5** — Sum the number of weapons by type which are engaging at this point in time. Calculate the losses as follows:

| KILLS BY BLUE | | KILLS BY RED |
|---|---|---|
| Number M60A1 | X .3 = | Number T62 X .02 = |
| Number M551 | X .15 = | Number BMP X .02 = |
| Number TOW | X .15 = | |
| Number DRAGON | X .15= | |

*In this example Blue's eleven M60A1 weapons generated 3.3 Red kills while six M551 weapons achieved 0.9 kills and two TOW an additional 0.3 kills. The total Red kills is 4.5 which is rounded to 5. Similarly 16 T-62 Red weapons generated 0.32 Blue kills which is rounded to zero.*

Distribute the losses to units using tactical judgment. *The losses distributed to the units, in this example, are one each to Company 1, 2, and 3 of the 1st Battalion. Two kills were assessed against Company 2 of the 2nd Battalion.* Mark off losses on the Red unit templates. Also enter the total losses for both Red and Blue on the graph. Do this by showing subtractions against the units recorded in Step. No. 3 at the top of the bar graphs.

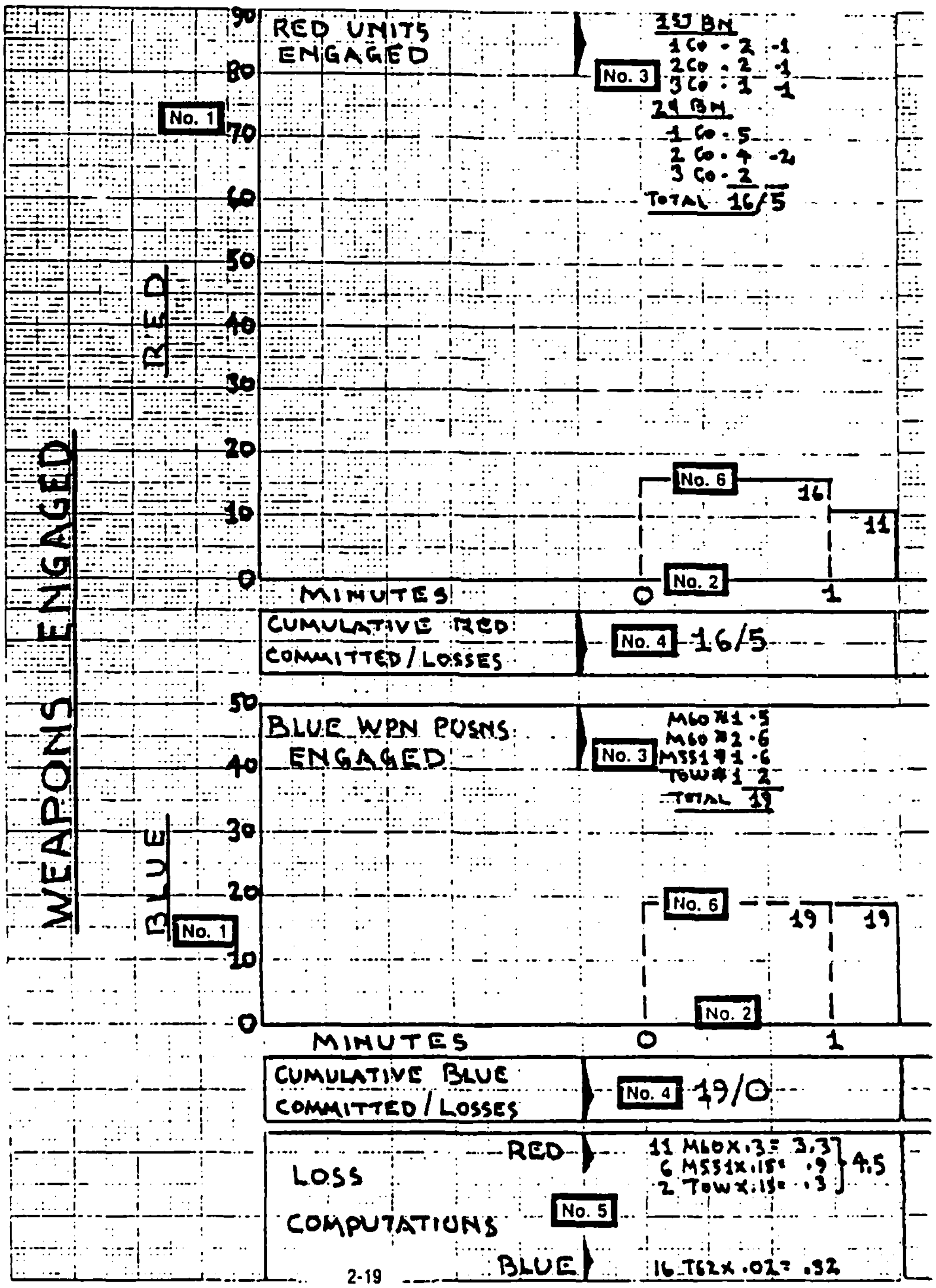
**STEP NO. 6** — Draw in, for each minute of the battle, bar graphs denoting the total weapons engaged (dashed line) by each opponent. Also graph the number of weapons remaining (solid line) at the end of this interval.

**STEP NO. 7** — Repeat the above steps for each one minute time interval of the battle. As you go to succeeding intervals be sure to account for Red and Blue losses from previous intervals. Red losses will be already marked on templates and will also be shown above the bar graphs. Blue losses will be recorded only above the bar graphs.

*If a Red weapon is in the coverage of more than one Blue unit, count the Red weapon only once.

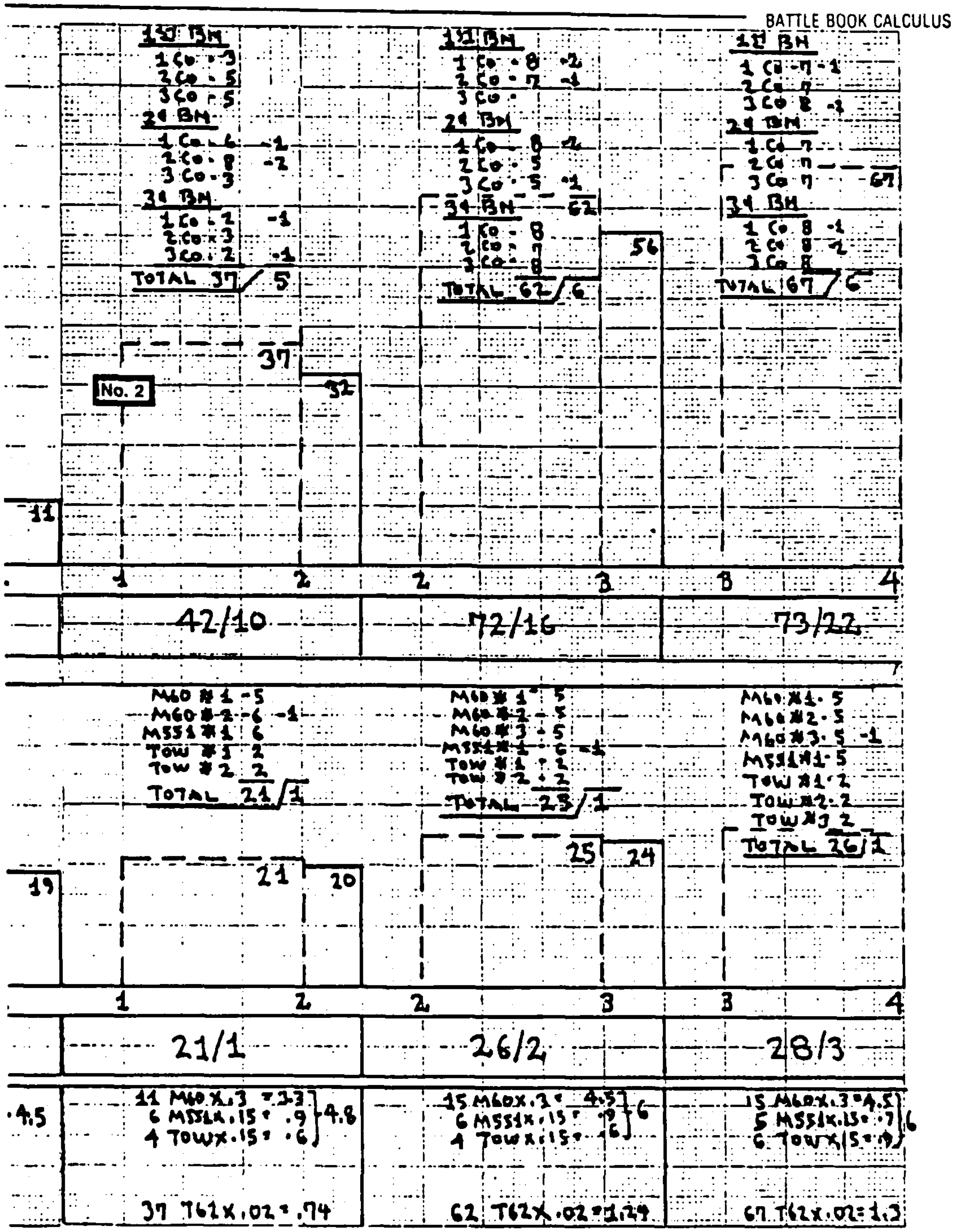
Inclosure 3, APP A: Loss Calculation Graphs

From: The BDM Corporation, Commander's Battle Book with Battle Book Calculus, (Fort Ord, California) (undated)



Inclosure 3, APP A: Loss Calculation Graphs

From: The BDM Corporation, Commander's Battle Book with Battle Book Calculus, (Fort Ord, California) (undated)



APP B Representative Tactical Quantification (US)

This appendix demonstrates the tactical quantification exercised in course of action development and analysis in current US tactical decision making. The methodology for these procedures is in Command and General Staff College Student Text 100-9, The Command Estimate. The two procedures demonstrated will be the estimate of relative combat power and the estimate of movement rates.

1. Relative combat power: The planner compares relative combat power by selecting a base unit and subjectively assigning each unit (both enemy and friendly) a combat power value relative to that unit. The ST 100-9 uses the Soviet BTR battalion as the base unit for that comparison, as demonstrated by FIG 1 (Table 4-1 from ST 100-9).

*Table 4—1. US vs Soviet Combat Unit Comparison Values*

| | | | |
|---|---|---|---|
| | MANEUVER | | |
| US (J-Series) | | Soviet | |
| M113 Bn | = 1.5 | BTR Bn | = 1 |
| M2 Bn | = 2 | BMP Bn | = 1.5 |
| M60 Bn | = 2.75 | Tk Bn (ITR) | = 2.6 |
| M1 Bn | = 3 | Tk Bn (TR) | = 1.6 |
| ACR Sqdn | = 2.75 | AT Bn | = 1 |
| Div Cav Sqdn (H) | = 2 | ITB/TB (MRR) | = 2.0 |
| Div Cav Sqdn | = 1.5 | | |
| Atk Hel Bn | = 4 | Atk Hel Bn | = 2 |
| | ARTILLERY | | |
| FA Bn | = 2 | FA Bn | = 2 |
| MLRS Btry | = 2 | MRL Btry | = 1 |

FIG 1

Relative combat power values are adjusted to account for the actual strength of participating units. These relative combat power values are then used to estimate a correlation of forces for the opposing sides. ST 100-9 recommends the estimation of two correlations: maneuver and artillery. An example calculation is at FIG 2 (Fig 4-1, ST 100-9).

**US**

| Type | #Bn | Value | Total |
|---|---|---|---|
| M2 | 4 | 2.0 | 8.0 |
| M1 | 6 | 3.0 | 18.0 |
| | | TOTAL | 26.0 |
| X% Strength | | | .9 |
| Relative combat powers | | | 23.4 |

Ratio for maneuver forces 23.4:22.0 = 1:1

| Type | #Bn | Value | Total |
|---|---|---|---|
| FA | 7 | 2.0 | 14.0 |
| X% Strength | | | .9 |
| Relative powers | | | 12.6 |

Ratio for artillery forces 12.6:9.8 = 1.3:1

**Soviet**

| Type | #Bn | Value | 17 GMRD Total | 5TD Total |
|---|---|---|---|---|
| BTR | 6 | 1.0 | 6.0 | |
| BMP | 4 | 1.5 | 4.5 | 1.5 |
| TB/MRR | 3 | 2.0 | 6.0 | |
| ITB/MRD | 1 | 2.0 | 2.0 | |
| TB/TR | 6 | 1.6 | 4.8(3) | 4.8(3) |
| | | | 23.3 | 6.3 |
| | | | .7 | .9 |
| | | | 16.3 | 5.7 |
| ARTY | | | | |
| FA | 7 | 2.0 | 14.0 | |
| | | | .7 | |
| | | | 9.8 | |

FIG 2

The correlation factors serve as guidelines to estimate the feasibility of missions. (FIG 3, (Table 4-3, ST 100-9) ).

*Table 4—3. Planning Ratios for the Array of Friendly Units*

| *Friendly Mission* | *Friendly: Enemy* | *Notes* |
|---|---|---|
| Delay | 1:6 | |
| Defend | 1:3 | Prepared or Fortified |
| Defend | 1:2.5 | Hasty |
| Attack | 3:1 | Prepared or Fortified |
| Attack | 2.5:1 | Hasty position |
| Counterattack | 1:1 | Flank |

FIG 3

The correlation of forces calculation can be developed for the entire sector of operations or for specific subsectors or subphases of the proposed course of action.

2. Estimate tools for rates of movement in ST 100-9 include two tables. Table 5-4 (Inclosure 1) is an adaptation of the CACDA Jiffy III War Game. It is

used for estimating feasible movement rates at brigade level and below. Table 5-5 (Inclosure 2) is a derivation of Dupuy's estimates in Numbers, Prediction and War. It is recommended for estimation of Division level movement rates.

Inclosure 1 - Table 5-4, ST 100-9, Brigades and Below Opposed Rates of Advance (in km/hr)

2 - Table 5-5, ST 100-9, Division Opposed Rates of Advance (in km/day)

Inclosure 1, App B: Table 5-4, ST 100-9, Brigades and Below Opposed Rates of Advance (in km/hr)

*Table 5—4. Brigades and Below Opposed Rates of Advance (in km/hour[1,2])*

| Degree of Resistance Attacker to Defender Ratio | PREPARED DEFENSE[4] | | | | | | HASTY DEFENSE[5] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GO TERRAIN | | SLOW-GO TERRAIN | | NO-GO TERRAIN | | GO TERRAIN | | SLOW-GO TERRAIN | | NO-GO TERRAIN | |
| | Arm/Mech | Inf | Arm/Mech | Inf | Arm/Mech | Inf | Arm/Mech | Inf | Arm/Mech | Inf | Arm/Mech | Inf |
| Intense Resistance 1:1 | .6 | .5 | .5 | .3 | .15 | .1 | 1.0 | .8 | .8 | .5 | .4 | .2 |
| Very Heavy 2:1 | .9 | .6 | .6 | .4 | .3 | .2 | 1.5 | 1.0 | 1.0 | .7 | .6 | .3 |
| Heavy 3:1 | 1.2 | .7 | .75 | .5 | .5 | .3 | 2.0 | 1.2 | 1.3 | .9 | .8 | .5 |
| Medium 4:1 | 1.4 | .8 | 1.0 | .6 | .5 | .5 | 2.4 | 1.4 | 1.75 | 1.1 | .9 | .8 |
| Light 5:1 | 1.5 | .9 | 1.1 | .7 | .6 | .5 | 2.6 | 1.6 | 2.0 | 1.2 | 1.0 | .9 |
| Negligible 6+:1 | 1.7+ | 1.0+ | 1.3+ | .8+ | .6+ | .6+ | 3.0+ | 1.7+ | 2.3+ | 1.3+ | 1.1+ | 1.0 |

Source: Adapted from CACDA Jiffy III War Game, Vol II, Methodology.

[1]Units cannot sustain these rates for 24 hours. These rates are reduced by ½ at night.
[2]The relative combat power ratio must be computed for the unit under consideration.
[3]When there is surprise, multiply these figures by a surprise factor as follows:
--Complete Surprise x 5 (e.g., Germans at the Ardennes in 1944, Arabs in 1973).
--Substantial Surprise x 3 (e.g., German invasion of Russia in 1941, Israelis' invasion of Sinai in 1967).
--Minor Surprise x 1.3 (e.g., Allied Normandy landing in 1944, Pakistanis' attack on India in 1971).
The effects of surprise last for 3 days, being reduced by one-third on day 2 and two-thirds on day 3.
[4]Prepared defense is based on defender in prepared positions (24 hours or more).
[5]Hasty defense is based on 2 to 12 hours preparation time.
[6]The ratios used here are to determine the degree of resistance. There is no direct relationship between advance rates and force ratios. However, sustained advances probably are not possible without a 3 to 1 ratio. Advance is possible against superior forces but cannot be sustained.
[7]Rates greater than 6 to 1 will result in advances between these and the unopposed rates.

## Inclosure 2, APP B: Table 5-5, ST 100-9, Division Opposed Rates of Advance (in km/day)

*Table 5—5. Division Opposed Rates of Advance (in km/day[1,3])*

| Degree of Resistance Attacker to Defender Ratio | PREPARED DEFENSE[3] | | | | | | HASTY DEFENSE/DELAY[4] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GO TERRAIN | | SLOW-GO TERRAIN | | NO-GO TERRAIN | | GO TERRAIN | | SLOW-GO TERRAIN | | NO-GO TERRAIN | |
| | Arm/Mech | Inf | Arm/Mech | Inf | Arm/Mech | Inf | Arm/Mech | Inf | Arm/Mech | Inf | Arm/Mech | Inf |
| Intense Resistance 1:1 | 2 | 2 | 1 | 1 | .6 | .6 | 4 | 4 | 2 | 2 | 1.2 | 1.2 |
| Very Heavy 2:1 (-) | 5-6 | 4 | 2-3 | 2 | 1.5-1.8 | 1.2 | 10-12 | 8 | 5-6 | 4 | 3-3.6 | 2.4 |
| Heavy 3:1 | 7-8 | 5 | 3-4 | 2.5 | 2.1-2.4 | 1.5 | 13-16 | 10 | 8 | 5 | 3.9-4.8 | 3 |
| Medium 4:1 | 8-10 | 6 | 4-5 | 3 | 2.4-3 | 1.8 | 16-20 | 12 | 10 | 6 | 4.8-6 | 3.6 |
| Light 5:1 | 16-20 | 10 | 8-10 | 5 | 4.8-6 | 3 | 30-40 | 18 | 20 | 9 | 9-12 | 5.4 |
| Negligible 6:1 | 24-30 | 12 | 12-15 | 6 | 7.2-9 | 3.6 | 48-60 | 24 | 30 | 12 | 14.4-18 | 7.2 |

Source: Numbers, Predictions and War, Dupuy, T. N., 1979.

[1]When there is surprise, multiply these figures by a surprise factor as follows:
--Complete Surprise x 5 (e.g., Germans at the Ardennes in 1944, Arabs in 1973).
--Substantial Surprise x 3 (e.g., German invasion of Russia in 1941, Israelis' invasion of Sinai in 1967).
--Minor Surprise x 1.3 (e.g., Allied Normandy landing in 1944, Pakistanis' attack on India in 1971).
The effects of surprise last for 3 days, being reduced by one-third on day 2 and two-thirds on day 3.
[2]Use the relative combat power from paragraph 2a(4) in the operations estimate.
[3]Prepared defense is based on defender in prepared positions (24 hours or more).
[4]Hasty defense is based on 2 to 12 hours preparation time.
[5]The ratios used here are to determine the degree of resistance. There is no direct relationship between advance rates and force ratios. However, sustained advances probably are not possible without a 3 to 1 ratio. *Advance is possible against superior forces but cannot be sustained.*
[6]Rates greater than 6 to 1 will result in advances between these and the unopposed rates.

## APP C Representative Tactical Quantification (Soviet)

1. Soviet tactical calculations are performed in a methodical algorithm that supports the staff planning process. The decision algorithm at Inclosure 1-1 is used in CGSC instruction for Course A352, Soviet Operational Art, and is representative of the logic employed in Soviet planning.

2. The representative tactical calculations described in this Appendix are extracted from various US and Soviet sources, particularly Vayner's Tactical Calculations.

a. Correlation of forces: The Soviets estimate both quantitative and qualitative force correlations for several indices of relative combat power. Initial quantitative estimates are converted to standard units of armament to achieve qualitative comparisons. The density of weapon systems per unit frontage is also calculated (Inclosure 2-1).

b. Artillery Fire Calculations: Unlike his US counterpart, the Soviet will calculate specific indirect fire support requirements to verify the feasibility of the fires portion of the course of action concept.

1) An example calculation of the surface suppression available from a particular fire means is at Inclosure 2-2.

2) An example calculation of the allowable firing time without changing positions is at Inclosure 2-3.

c. Reconnaissance Requirements: Because of their quantitative approach to tactical decision making, the availability of input data for the quantitative model is the driving impetus for the Soviet emphasis on reconnaissance. The required reconnaissance effort is estimated through calculations such as the one at Inclosure 2-4.

d. Opposed movement rates and attrition: The Soviets believe that movement rates and expected attrition are related to force correlations that can be modeled through Lanchester-type equations. The nomogram at Inclosure 2-5 demonstrates a nomogram that relates correlation of forces and movement. Inclosure 2-6 depicts the estimated relationship between correlation of forces and attrition.

e. Movement planning: The Soviets do not relegate movement planning to an isolated subportion of the staff; they expect all planners to take objective consideration of the time-space considerations of large-scale movement. The examples at Inclosures 2-7 and 2-8 are only a portion of the 23 movement formulas elaborated in Vayner's Tactical Calculations.

Inclosures:

1-1 - Decision Algorithm
2-1 - Correlation of Forces Calculation
2-2 - Surface Suppression of Fires Calculation
2-3 - Permissible Firing Time Calculation

2-4 - Determination of Reconnaissance Search Length Calculation
2-5 - Correlation of Forces and Movement Rates
2-6 - Correlation of Forces and Attrition
2-7 - Road (Route) Throughput Calculation
2-8 - Passage Time of a Column into a Concentration Region

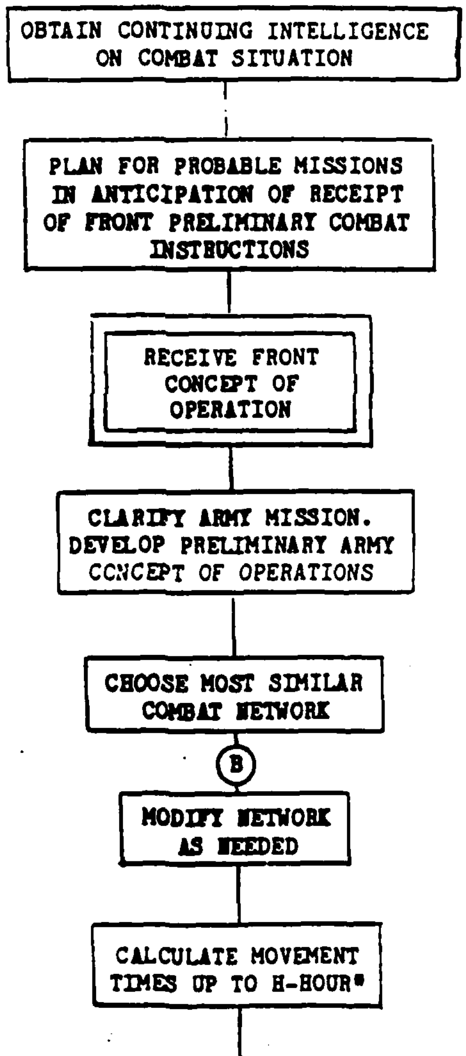
Inclosure 1-1, APP C: Decision Algorithm

From CGSC Instruction A352: Soviet Operational Art, AY 86-87

**U.S. ARMY COMMAND AND GENERAL STAFF COLLEGE**

**SOVIET OPERATIONAL ART**

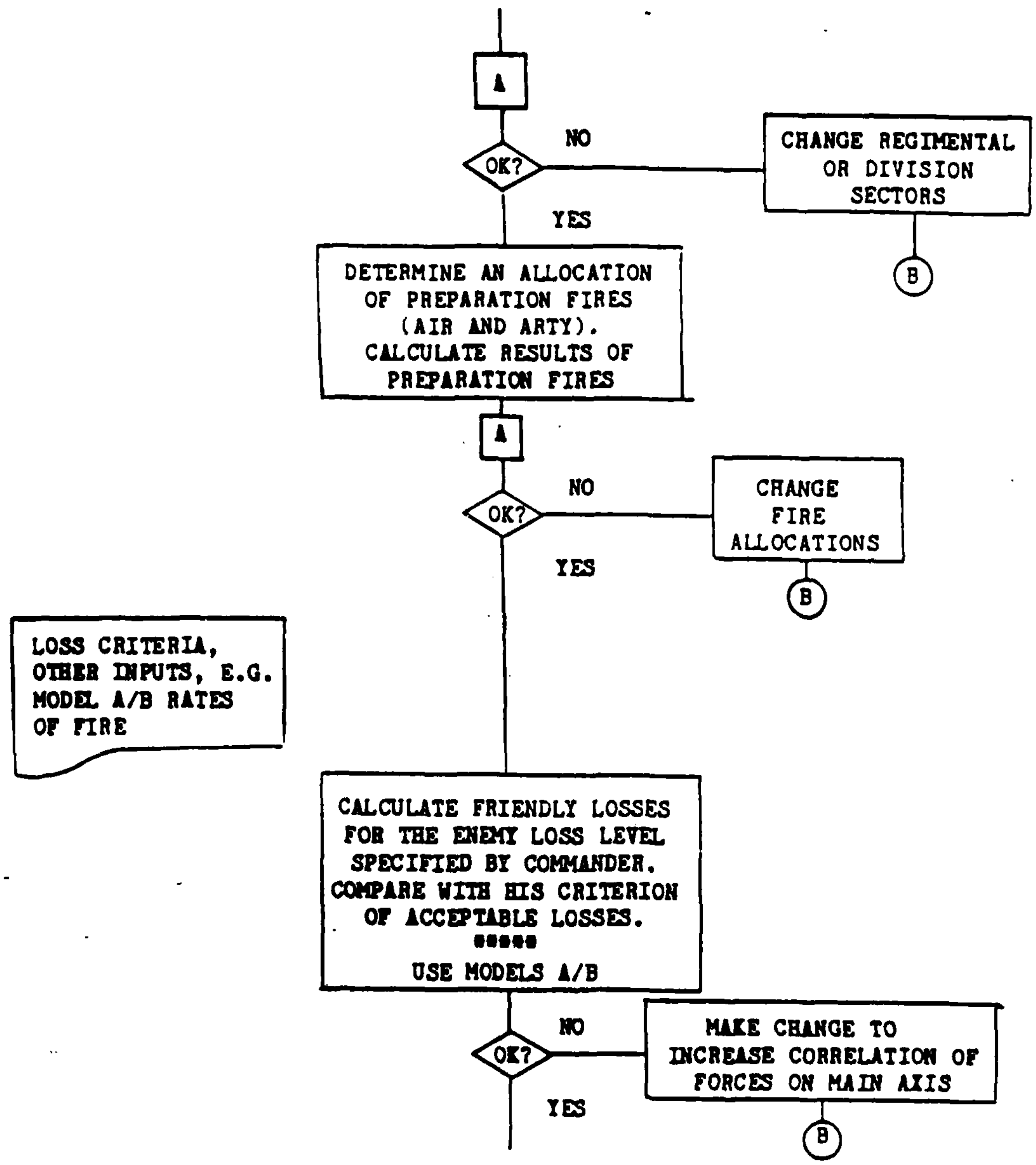
**Appendix 7 to Section I. Army Level Planning--Analytic Architecture**




*AFTER FIRST TIME THROUGH, INCREMENT BY TC

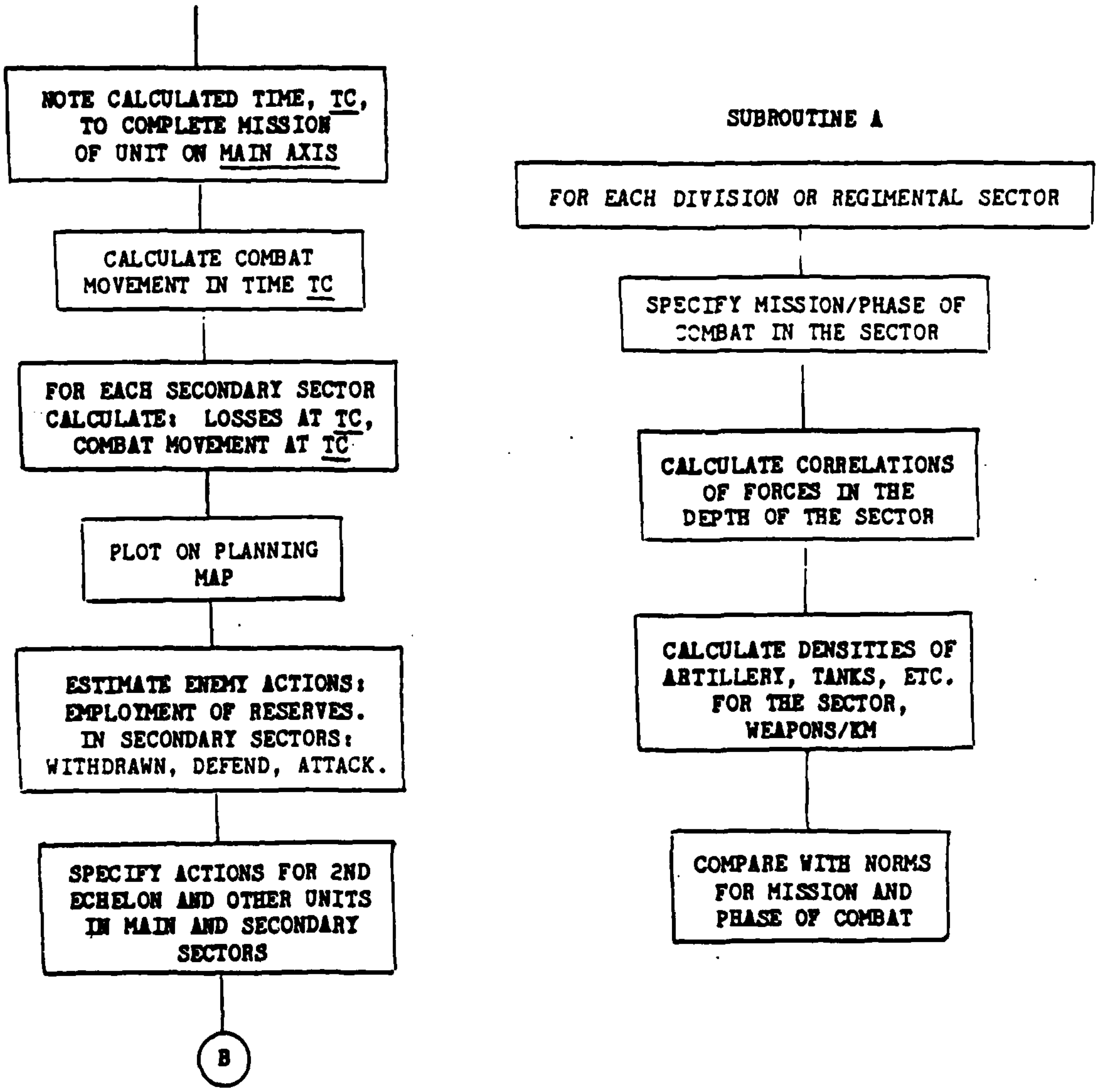
Inclosure 1-1, APP C: Decision Algorithm

From CGSC Instruction A352: Soviet Operational Art, AY 86-87



Inclosure 1-1, APP C: Decision Algorithm

From CGSC Instruction A352: Soviet Operational Art, AY 86-87



Inclosure 2-1, APP C: Correlation of Forces Calculation

From CGSC Instruction A352: Soviet Operational Art, AY 86-87

## CORRELATION OF FORCES OF THE SIDES

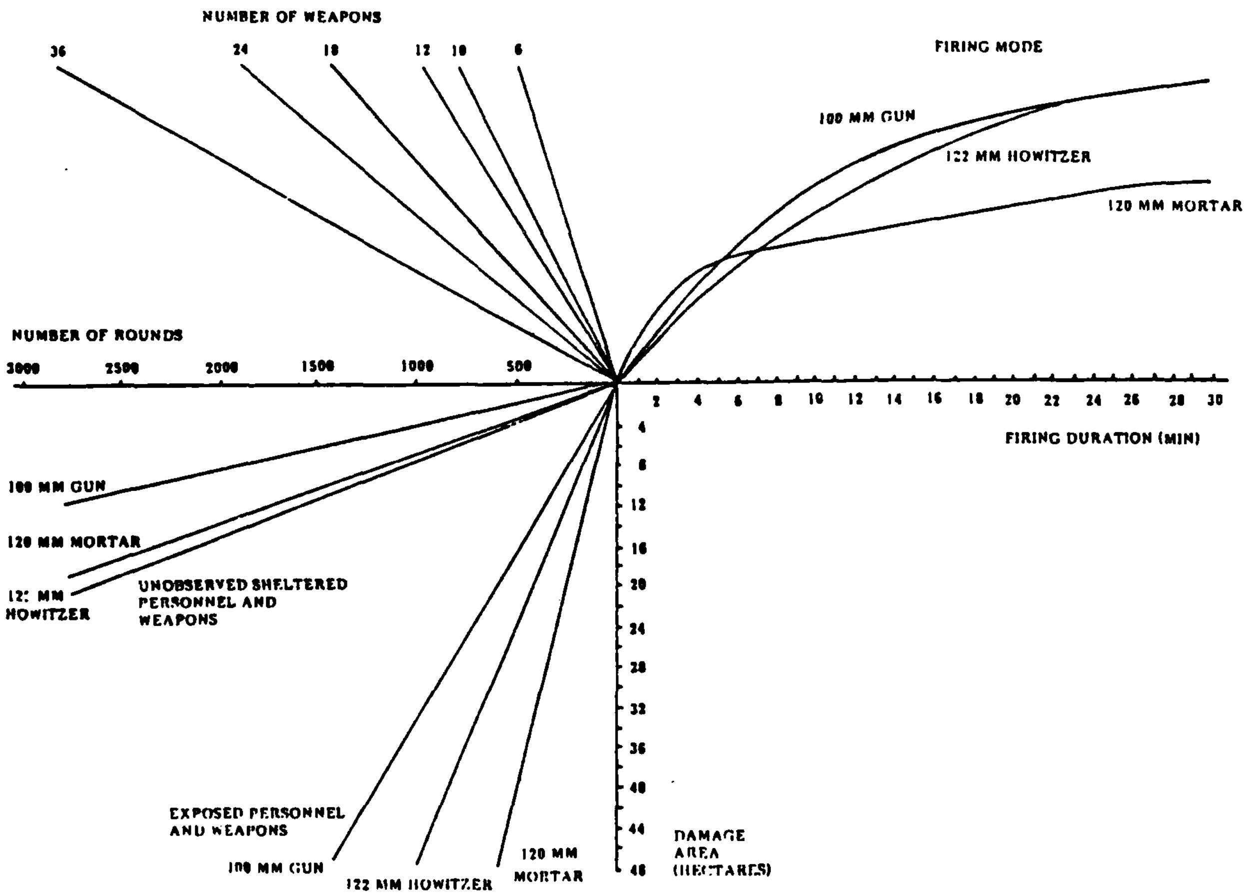
**Length of FRONT:**

| Forces & Means | Ours (Soviet) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Enemy | | | | | | | |
| | Quantity | | Quality | | Correlation | | Density | |
| | Ours | Enemy | Ours | Enemy | According to Quantity | According to Quality | Ours | Enemy |
| Divisions | | | | | | | | |
| Tank<br>Motorized Rifle | | | | | | | | |
| Tanks | | | | | | | | |
| Infantry Fighting Vehicles | | | | | | | | |
| Antitank Assets | | | | | | | | |
| Helicopters w/ ATGM | | | | | | | | |
| Air Defense | | | | | | | | |
| Nuclear Weapons | | | | | | | | |
| Guns and Mortars | | | | | | | | |
| Total | | | | | | | | |

Inclosure 2-2, APP C: Surface Suppression of Fires Calculation

From Vayner's Tactical Calculations (Voennoye Izdatel'stvo: Moscow, 1982), pp 40-41.

**NOMOGRAM EMPLOYED TO DETERMINE EFFECTIVENESS OF ARTILLERY BARRAGES (U)**




1. To determine the firing capabilities of 12 122-mm howitzers in suppressing enemy personnel in the open with a 15 minute artillery strike.

In the calculation (variant "a), we establish a perpendicular line from the "15" mark on the "Firing time" scale and continue it to the intersection with the "122-mm howitzer" curve. From the point of intersection, we draw a vertical line downwards to the "Personnel and weapons in the open-122-mm howitzer" line. From the point of intersection we draw a horizontal line to the "Destruction area" scale, where we read the result - 33 hectares, i.e., in these particular conditions, the area of destruction of personnel in the open is 33 hectares.

Inclosure 2-3, APP C: Permissible Firing Time Calculation

From Vayner's Tactical Calculations (Voennoye Izdatel'stvo: Moscow, 1982), pp 47-48.

The initial data for calculation is the effective firing range of the weapons (artillery, mortars) proceeding from the tactical and technical characteristics of the weapons and the conditions, the established distance of the firing positions from the forward operating subunits and the speed of movement of the subunits and the shifting of the weapons with a change in their positions. Moreover, the time it takes to close up and deploy the weapons to the new positions should be taken into consideration.

The calculation formula is:

$$t = \left[\frac{(D-d)}{V_f} - \frac{(D-d)}{V_c}\right](60) - t_c \quad \text{or}$$

$$t = (D-d)\left(\frac{1}{V_f} - \frac{1}{V_c}\right)(60) - t_c$$

where t is the length of firing without a change in the firing positions or the permissible time for the weapon to remain in one position, minutes; D is the effective firing range of the weapon, kilometers; d is the established distance of the firing positions from the forward operating forces, kilometers; $V_f$ is the rate of advancement of the operating forces, kilometers per hour; $V_c$ is the travel speed of the weapons with a change in position, kilometers per hour; 60 is the factor for converting hours into minutes and $t_c$ is the time it takes to close up and deploy the systems, minutes.

Using this particular technique, it is possible to conduct calculations for a change in the firing positions not only of weapons systems (artillery, mortars), but also antiaircraft defense forces, reconnaissance and communications systems and command post disposition points.

Calculation example. To determine the permissible time for conducting firing by mortars without a change in the positions when the positions are 3 kilometers from the forward operating forces, the effective firing range is 7.5 kilometers, the rate of advancement of the forward operating forces is 5 kilometers per hour, the speed for shifting weapons systems during a change in positions is 25 kilometers per hour and the close up and deployment time is 15 minutes.

Solution

$$t = \left[\frac{(7.5-3)}{5} - \frac{(7.5-3)}{25}\right](60) - 15 = \left(\frac{4.5}{5} - \frac{4.5}{25}\right)(60) - 15 = (0.9-0.18)(60) - 15$$

$$= (0.72)(60) - 15 = \text{approximately } 43-15 = \text{approximately } 28 \text{ minutes.}$$

Inclosure 2-4, APP C: Determination of Reconnaissance Search Length Calculation

From Vayner's Tactical Calculations (Voennoye Izdatel'stvo: Moscow, 1982), pp 62-63.

Target detection probability

This technique makes it possible to calculate the probability of target detection with a search in an assigned region. The initial data for the calculation are the length and speed of the search, the range of reliable target detection of the reconnaissance systems. Here, it is taken into consideration that at this range the target is detected with a reliability which approaches 1.

Calculation formula: $P = 2RVt/S$ at $2RVt$ is less than or equal to $S$, where $P$ is the probability of target detection; $R$ is the effective range of reliable observation in kilometers; $V$ is the search speed in kilometers per hour; $t$ is the search time in hours and $S$ is the surface area of the search region in square kilometers.

Calculation example. Determine the probability of target detection in 2.5 hours in a region whose surface area is 37 square kilometers when the search speed is 4 kilometers per hour.

Solution: $P = (2)(1.3)(4)(2.5)/37 = 0.7$.

Inclosure 2-5, APP C: Correlation of Forces and Movement Rates

Unclassified Extract from Foreign Systems Research Center Course on Soviet Troop Control, Science Applications, Inc., 4-15 November 1985.

**APPROACH TO COMPARING ALTERNATIVE CONCEPTS OF THE OPERATION (U)**
**(BASED ON FORCES REQUIRED ON MAIN SECTOR)**

1. (U) DEFINE ENEMY FORCES TO BE ENGAGED AS A PART OF EACH PROPOSED MAIN SECTOR (BOUNDARIES ARE NOT YET IMPORTANT) TO THE DEPTH OF THE OPERATION

2. (U) CALCULATE THE COMBAT STRENGTH OF THESE ENEMY GROUPINGS

3. (U) DETERMINE THE DEPTH OF THE AXES OF ADVANCE FROM THE MAP

4. (U) SELECT APPROPRIATE SPEED ADJUSTMENT COEFFICIENTS FOR THE TERRAIN — DIVIDE UP THE OPERATION IF NECESSARY

| | | | |
|---|---|---|---|
| LEVEL, SMOOTH | 1.0 | RUGGED, VALLEYS | .5 |
| LEVEL, ROUGH | .8 | RUGGED, MOUNTAINS | .2 |

UNCLASSIFIED

5. (U) CALCULATE THE FORCES REQUIRED TO MEET THE TIMETABLE OF ADVANCE

6. (U) COMPARE THE RESULTS

**NOMOGRAM FOR CORRELATION OF FORCES NEEDED TO CONDUCT AN OFFENSIVE (U)**

*(STEP 1)*

$$F = \frac{D}{K\,T\,V_{MAX}}$$

D: DEPTH OF MAIN AXIS

K: SPEED ADJUSTMENT COEFFICIENT

$V_{MAX}$: SPEED ATTAINABLE IN COMBAT FORMATION (65 KMPH)

T: TIME ALLOWED TO COMPLETE THE OPERATION

IF MAIN AXIS IS DIVIDED INTO SEPARATE SECTIONS, TAKE THE SUMS OF ALL THE D AND K PARAMETERS IN THE PLACE OF EACH OF THEM, I.E.,

$$K = (D_1 K_1 + D_2 K_2 + \cdots)/D$$

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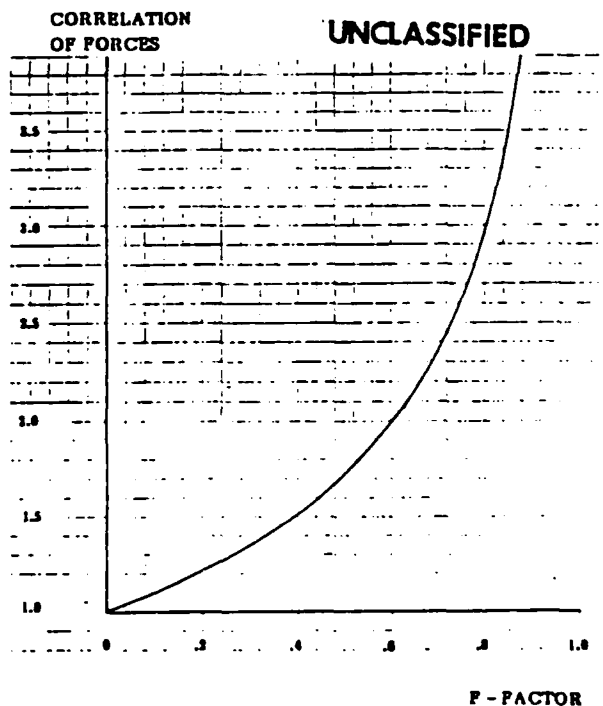


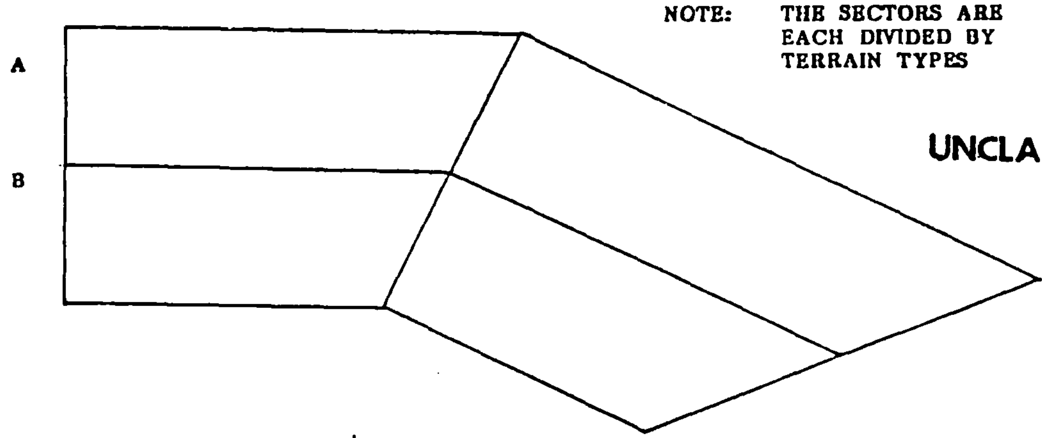
Inclosure 2-5, APP C: Correlation of Forces and Movement Rates

Unclassified Extract from Foreign Systems Research Center Course on Soviet Troop Control, Science Applications, Inc., 4-15 November 1985.

**EXAMPLE PROBLEM FOR COMPARING CONCEPTS OF THE OPERATION (U)**

(U) FIND THE FORCE STRENGTHS REQUIRED TO REACH THE FINAL LINES IN THE SECTORS SHOWN. (EACH SECTOR IS CONSIDERED AS THE MAIN AXIS)

NOTE: THE SECTORS ARE EACH DIVIDED BY TERRAIN TYPES




UNCLASSIFIED

| | A | B |
|---|---|---|
| $D_1$ | 300 | 200 |
| $D_2$ | 350 | 250 |
| $K_1$ | .8 | .8 |
| $K_2$ | .5 | .2 |
| ENEMY: | | |
| STRENGTH | 450 | 500 |
| ACTIONS | MOBILE DEFENSE | MOBILE DEFENSE |

T = 10 DAYS
V = 65 km/da

Solution:

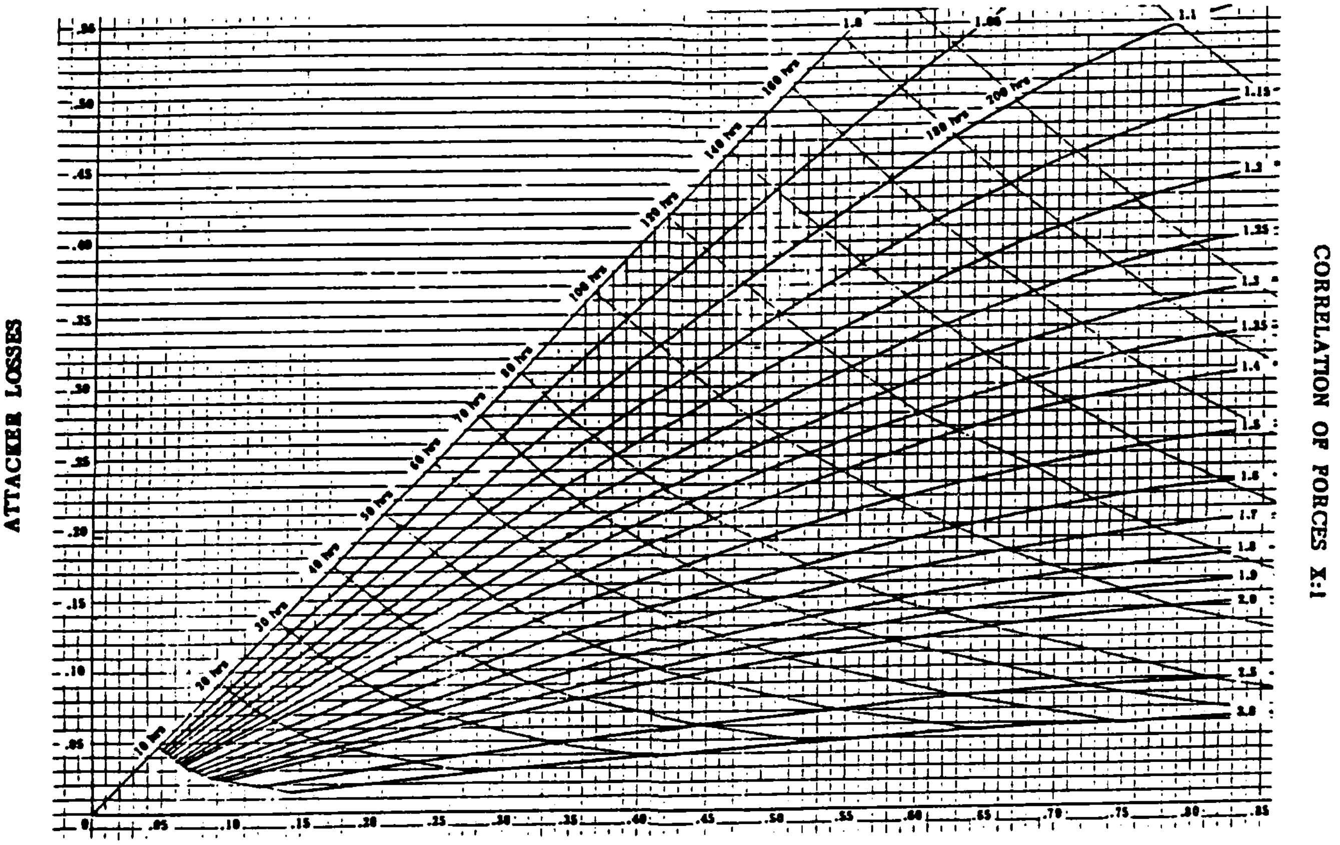
| SECTOR | F | COF INDEX | FORCE POTENTIAL |
|---|---|---|---|
| A | .77 | 2.8 | 1,250 |
| B | .69 | 2.3 | 1,150 |

VIRTUALLY INDIFFERENT TO FORCES REQUIRED

Inclosure 2-6, APP C: Correlation of Forces and Attrition

Unclassified Extract from Foreign Systems Research Center Course on Soviet Troop Control, Science Applications, Inc., 4-15 November 1985.

FORCE ATTRITION NOMOGRAM BASED ON CORRELATION OF FORCES AND TIME (ARMY LEVEL) (U)



Inclosure 2-7, APP C: Road (Route) Throughput Calculation

From Vayner's Tactical Calculations (Voennoye Izdatel'stvo: Moscow, 1982), pp 60-61.

Route throughput

The technique is designed for calculating the throughput of routes relative to the quality of the road, the nature of the transport travel and the travel conditions.

The initial data for the calculation are the transport travel speed, the established distance between the vehicles, the nature of the travel (one-way, two-way), the throughput reduction factor because of travel in columns and the factors which take into consideration the intersection of the route by railraods with varying railroad traffic.

The calculation formula is N = (Vqk)/dK(1,000), where N is the throughput of the road in vehicles per hour; V is the travel speed in kilometers per hour; q is the factor which takes into consideration the influence of oncoming traffic with two-way travel (1.6); k is the factor which takes into consideration the train traffic on the intersecting railroad (30 pairs of trains per day - 0.75; 40 pairs - 0.65; 50 pairs - 0.57; 60 pairs - 0.5 and 70 pairs - 0.4); d is the distance between vehicles in meters; K is the throughput reduction factor because of travel in columns at speeds of: 10 kilometers per hour - 2.8; at 20 kilometers per hour - 2.4; at 25 kilometers per hour - 2.2; at 30 kilometers per hour - 2; at 40 kilometers per hour - 1.8 and at 50 kilometers per hour - 1.6; and 1,000 is the factor for converting kilometers into meters.

Calculation example. Determine the throughput of a route leg with the condition that the permissible travel speed is 30 kilometers per hour, there is two-way traffic, the distance between the vehicles is 75 meters and the route is intersected by a main railroad with a traffic level of 50 pairs of trains per day.

Solution: N = ((30)(1.6)(0.57)/((75)(2))(1,000) is approximately 182, i.e., in these particular conditions the throughput of the leg per hour is 182 vehicles. With a reduction in the distance between the vehicles to 25 meters, the throughput rises to 546 vehicles per hour. When the railroad crossing is eliminated, the throughput with the very same conditions rises to 960 vehicles per hour.

Inclosure 2-8, APP C: Passage Time of a Column into a Concentration Region

From Vayner's Tactical Calculations (Voennoye Izdatel'stvo: Moscow, 1982), pp 26-27.

**Passage time of a route column into a concentration region**

The passage time of a route column into a new concentration region is determined when the depth of this region is less than the depth of the route order.

The initial data for calculation are the depth of the concentration region, the depth of the route column and the travel speed upon passage, which is made up relative to the conditions of 0.5-0.75 of the average march speed.

The calculation formula is $t_{pl} = (D_c - D_r)/V_p \times 60$, where $t_{pl}$ is the passage length of the route column into the concentration region, in minutes; $D_c$ is the depth of the route column in kilometers; $D_r$ is the depth of the concentration region in kilometers; $V_p$ is the travel speed of the route column with passage in kilometers per hour and 60 is the factor for converting hours into minutes.

Calculation example. To determine the length of passage of a route column into a concentration region when the depth of the column is 7 km, the depth of the concentration region is 3.5 km and the travel speed of the column upon passage is 10 km/h.

Solution: $t_{pl} = (7 - 3.5)/(10)(60) = 0.35 \times 60 = 21$ minutes.

## APP D Potential Automation of Tactical Quantification

This appendix contains examples of the application of personal microcomputers and software to reduce the tediousness and inconvenience previously associated with complex tactical quantification calculations.

1. **Correlation of forces**: The complex and unique task organizations associated with each combat mission render such calculations too tedious for manual calculation by a hard pressed tactical planner. Electronic spreadsheets are uniquely suited to calculation requirements that include successive multiplication and additions. Electronic spreadsheets perform realtime calculations on cells, rows, or columns. A careful representation of tactical units in a matrix of hierarchical relationships makes it possible to represent most unit task organizations. The instantaneous calculation of relative combat power is then relatively straightforward.

FASTCALC is an electronic spreadsheet that does a rapid estimate of the relative correlation of forces for typical combinations of opposing US and Soviet units. FASTCALC depicts Soviet and US organizations in three general categories of combat power: ground maneuver, combat aviation and artillery. The relative attrition of each type unit may be adjusted. The user is offered a selection of several units and subunits, allowing the depiction of most unit task organizations. A spreadsheet window at the bottom of the screen keeps the user continuously appraised of the relative combat power (Inclosure 1-1). This information can also be depicted in a color bar graphic (Inclosure 1-2). A complete printout of the spreadsheet documents the calculations of relative combat power (Inclosure 1-3).

2. **Planning Time**: The allocation of planning and preparation time is of critical interest to every planner in the Airland Battle. Planning time is especially important for the multiecheloned fight, where excessive delay in higher echelon planning may render the tasks of subordinate units impossible. The accurate forecasting of planning and preparation times is one of the initial requirements of the planning process. Most planners rely on the venerable "1/3 -2/3" rule of thumb, which allocates 1/3 of the available time to planning, leaving the other 2/3 to subordinate units. The scheduling and estimating of the planning process is relatively straightforward but rarely accomplished to any level of detail.

Spreadsheets have functions that perform calculations on dates and times, making them ideal for rapid calculation of planning schedules and time impacts.

One must establish several definitions prior to automating calculations of multiechelon planning impacts. Key definitions used in FASTPLAN include:

Planning Time: The time from receipt of warning order at one echelon to issuance of warning order to the subordinate echelon.

Preparation Time: The time from receipt of warning order at one echelon until time of mission execution for that echelon.

Warning Notice: A heads up warning that a new mission, as yet undefined, is likely.

Warning Order: A preliminary notice of an action or order that is to follow. Usually issued as a brief oral or written message, it is designed to give subordinates time to make necessary plans and preparations. (FM 101-5-1, p 1-75.) A warning order should include: situation, time and nature of the operation, earliest time of move, time/place for oporder issuance, and special instructions. (FC 7-5, p 5-9). The warning order is issued as soon as possible after the commander's decision to allow subordinate elements to begin planning while the formal order is being processed at the higher headquarters.

FASTPLAN allows the user to allocate planning time between both the echelons of command and the steps of the planning process at each echelon. FASTCALC calculates the estimated planning schedule from Corps to Company Team for the following planning phases:

Mission analysis and Commander's Guidance
Warning Notice Out
Analysis and Decision
Warning Order

The user also estimates the minimum time required for the following types of planning:

Fully Staffed Mission Order (Oporder prepared through a complete application of the 11 steps of the estimate process)
Cdr's Mission Order (Oporder in which the commander dictates a course of action which the staff fleshes out and coordinates
Written Fragorder (requires transmission of written message)
Verbal Fragorder (requires assembly of orders group for face-to-face coordination
Radio Fragorder

FASTPLAN compares the planning schedule against these minimum time requirement estimates, presenting an instant visualization of the type of planning feasible at every level of the command. (Inclosure 2-1)

Two graphic outputs are available: a presentation of the minimum planning time estimates vs the available time at every echelon (Inclosure 2-2), and the preparation time available at every echelon (Inclosure 2-3).

A printout of the report documents the planning schedule analysis. (Inclosure 2-4)

3. **Movement Calculations**: Movement has been described as the essence of operational art. Movement calculations are individually simple but become complex for large movements because of the volume of detail involved. The Soviets have developed several movement formulas and associated nomographs (Vayner, 1982). Nomographs are especially useful in that they can solve for any of the variables used to develop the nomograph relationship. Many American officers find nomographs confusing and not "straightforward".

For tactical calculations based on linear equations, electronic spreadsheets are generally superior to nomographs. Logical condition statements and careful organization can lead to "electric nomographs" that instantly solve for the undefined variable of the tactical equation. Such spreadsheets are much more accurate and straightforward than nomographs.

FASTMOVE is a series of electronic spreadsheets based on tactical movement formulas in Vayner's 1982 text, "Tactical Calculations". Each spreadsheet presents the tactical problem to be solved, the formula, and a list of variables with their units of measure and definition. For most problems the user inputs known variables, the spreadsheet automatically solves for the Nth variable after N-1 inputs have been accomplished.

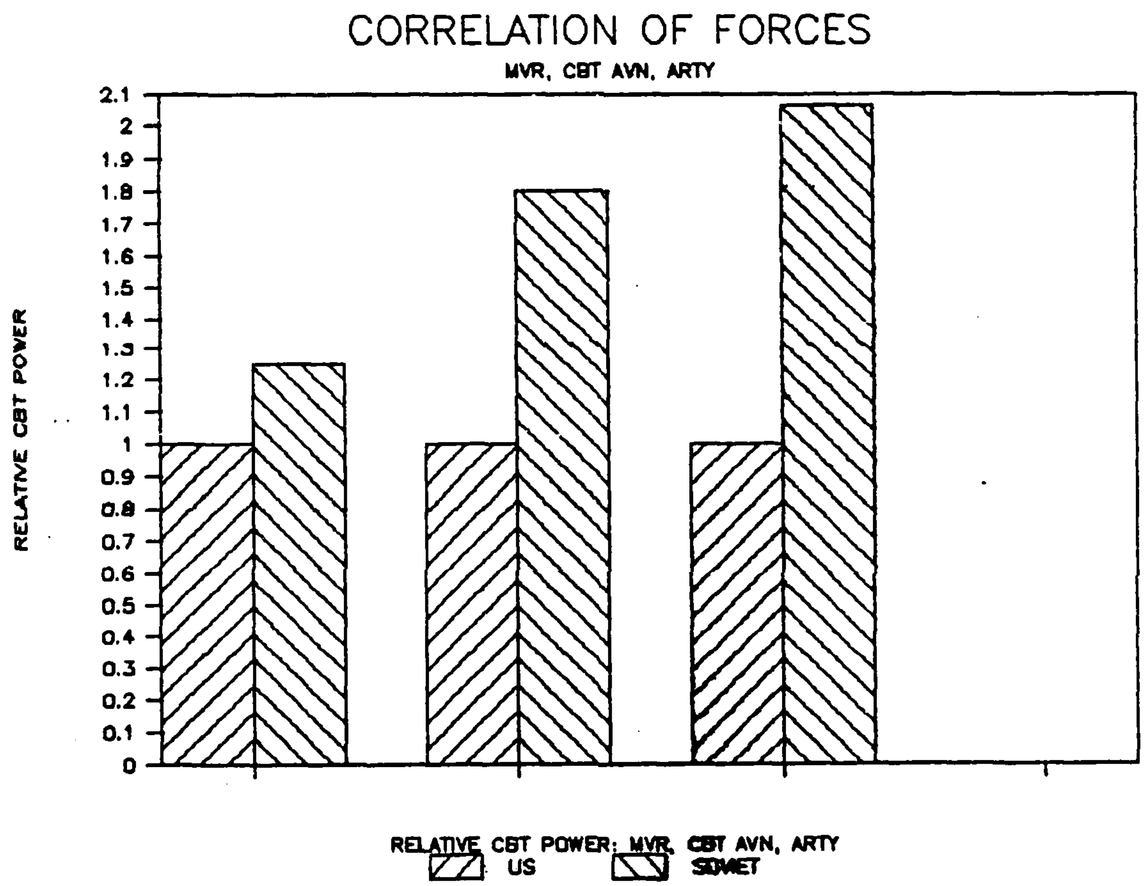
Inclosures:

- 1-1 - Sample FASTCALC Screen Image
- 1-2 - FASTCALC Decision Graphic
- 1-3 - FASTCALC Correlation of Forces Report
- 2-1 - Sample FASTPLAN Screen Image
- 2-2 - Decision Graphic, Minimum Planning Time Estimate vs Available Planning Time
- 2-3 - Decision Graphic, Available Preparation Times
- 2-4 - Planning Schedule Report
- 3-1 - FASTMOVE1: Time Required for the Advancement of a Subunit from One Region to Another
- 3-2 - FASTMOVE2: Entry Time of a Route Column to Arrive at a Designated Point
- 3-3 - FASTMOVE3: Concentration Time
- 3-4 - FASTMOVE4: Rail Transportation Time

Inclosure 1-1, APP D: Sample FASTCALC Screen Image

```
             A                B        C    D    E    F    G    H    I    J    K
1   ******************************************************************************
2                                           SOVIET MANEUVER UNITS (DIV-BN)
3                                                (ATTRITION FACTORS)
4         ORGANIC                      MRD  TD   MRR  TR   MRB  TB   ATB  RECON ITB
5        SUBUNITS                     1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
6   MTRZD RIFLE DIV   4-33                1 ****************************************
7   TANK DIVISION     4-106          *****    1 ***********************************
8   MRR (BTR)         4-8                 2 *****    0 ******************************
9   MRR (BMP)         4-26                1    1     0 ******************************
10  TANK REGT (MRD)   4-42                1 **********    0 *************************
11  TANK REGT (TD)    4-101          *****    3 *****     0 *************************
12  MRB (BTR)         4-4                 6 *****    0 *****    0 ********************
13  MRB (BMP)         4-24                3    6     0    0     0 ********************
             A                B        C    D    E    F    G    H    I    J    K
130                                                      US   SOV       US:SOV
131 Concept by:                                MANEUVER: 38.8 48.5    1   :   1.24
132      Major David A. Fastabend              CBT AVN:  26.5 47.8    1   :   1.80
133      82 3rd Infantry Road                  ARTILLERY:35.6 73.4    1   :   2.06
134      Fort Leavenworth, KS, 66027
135      913-651-0356
06-Oct-87  10:53 PM
```

Inclosure 1-2, APP D: FASTCALC Decision Graphic



Inclosure 1-3, APP D: FASTCALC Correlation of Forces Report

```
*******************************************************************************************
                                SOVIET MANEUVER UNITS (DIV-BN)                  *
                                   (ATTRITION FACTORS)                      TOTAL*COMBAT UNIT   CURRENT
    ORGANIC                   MRD  TD   MRR  TR   MRB  TB   ATB  RECON ITB TYPE *EFFECT COMBAT COMBAT
    SUBUNITS                  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 UNIT *TOTAL  POWER  POWER
MTRZD RIFLE DIV  4-33            1 ***************************************   1 *  1.00  24.25  24.25
TANK DIVISION    4-106        *****    1 ********************************   1 *  1.00  24.22  24.22
MRR (BTR)        4-8             2 *****    0 *****************************   2 *  2.00   5.52  11.04
MRR (BMP)        4-26            1    1    0 *****************************   2 *  2.00   7.02  14.04
TANK REGT (MRD)  4-42            1 **********    0 ************************   1 *  1.00   4.79   4.79
TANK REGT (TD)   4-101        *****    3 *****    0 ***********************   3 *  3.00   6.29  18.87
MRB (BTR)        4-4             6 *****    0 *****    0 ******************   6 *  6.00   1.00   6.00
MRB (BMP)        4-24            3    6    0    0    0 *******************   9 *  9.00   1.50  13.50
TK BN (MRR)      4-14            3 *****    0 **********    0 **************   3 *  3.00   2.07   6.21
TK BN (TK REGT)  4-100           3    9 *****    0 *****    0 **************  12 * 12.00   1.53  18.36
ANTITANK BN      4-66            1 ************************    0 **********   1 *  1.00   1.00   1.00
RECON BN         4-67            1    1 ************************    0 *****   2 *  2.00   0.40   0.80
IND TANK BN      4-97         ***************************************    0   0 *  0.00   2.50   0.00
RECON CO (REGT)  4-15            4    4    0    0 ************************   8 *  8.00   0.20   1.60
ATGM BTRY (REGT) 4-16            3    1    0 *****************************   4 *  4.00   0.25   1.00
                                                                           *SOV MVR TOTAL: 48.47
                                SOVIET ARTILLERY UNITS
                                  (ATTRIT
                                  MVR  HOW  HOW  HOW  HOW
                              DIV  REGT BN   SP BNBN   SP   RLB  SSM        TOTAL*COMBAT UNIT   CURRENT
    ORGANIC                   ARTY ARTY 122mm122mm152mm152mmBN   BN         TYPE *EFFECT COMBAT COMBAT
    SUBUNITS       ATTRIT:   1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00       UNIT *TOTAL  POWER  POWER
ARTY REGT          4-47         2 *********************************            2 *  2.00  23.00  46.00
MRR (BTR)          4-8       *****    2 *****************************            2 *  2.00   2.00   4.00
MRR (BMP)          4-26      *****    2 *****************************            2 *  2.00   2.20   4.40
TANK REGT          4-42      *****    4 *****************************            4 *  4.00   2.20   8.80
HOW BN 122 MM      4-51         4    2    0 ***********************            6 *  6.00   2.00  12.00
HOW BN 122MM (SP)  4-31      *****    6 *****    2 *******************            8 *  8.00   2.20  17.60
HOW BN 152MM       4-114     *******************    0 ***************            0 *  0.00   2.50   0.00
HOW BN 152MM (SP)  4-52         2 *******************    2 **********            4 *  4.00   2.70  10.80
ROCKET LCHR BN     4-53         2 ************************    3 *****            5 *  5.00   6.00  30.00
ROCKET LCHR BTRY   4-54         6 ************************    9 *****           15 * 15.00   2.00  30.00
SSM BN             4-65      **********************************    2            2 *  2.00   1.50   3.00
                                                                              SOV ARTY TOTAL 72.40
                                SOVIET COMBAT AVIATION
                                  (ATTRITION FACTORS)                          *                 0.00
                              ATK  DIV                                         *                 0.00
                              HEL  HEL                                     TOTAL*COMBAT UNIT   CURRENT
    ORGANIC                   REGT SQDN                                    TYPE *EFFECT COMBAT COMBAT
    SUBUNITS       ATTRIT:   1.00 1.00                                     UNIT *TOTAL  POWER  POWER
ATK HEL REGT       4-122        1 *****                                       1 *  1.00  33.75  33.75
HIND SQUADRON      4-122        2 *****                                       2 *  2.00  13.50  27.00
HIP SQUADRON       4-122        1 *****                                       1 *  1.00   6.75   6.75
DIV HEL SQDN       4-93      *****    2                                       2 *  2.00   7.00  14.00
MI-2 HOPLITE FLT   4-93      *****    4                                       4 *  4.00   0.50   2.00
MI-8 HIP FLT       4-93      *****    4                                       4 *  4.00   1.00   4.00
MI-24 HIND FLT     4-93      *****    4                                       4 *  4.00   2.00   8.00
                                                                                                 47.75
*******************************************************************************************

                                US MANEUVER UNITS (DIV - BN)
```

Inclosure 1-3, APP D: FASTCALC Correlation of Forces Report

```
                              (ATTRITION FACTORS)
                                                             DIV REGT
                         MECH ARMOR SEP AVN  ACR  INF  ARMOR CAV CAV  TOTAL*COMBAT UNIT   CURRENT
   ORGANIC               DIV  DIV   BDE BDE       BN   BN    SQN SQN  TYPE *EFFECT COMBAT COMBAT
   SUBUNITS    ATTRIT:   1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 UNIT *TOTAL  POWER  POWER
MECH INF DIV   87-J         1 ########################################    1 *  1.00  29.00  29.00
ARMOR DIV      87-J      #####    0 ###################################    0 *  0.00  29.76   0.00
SEP BDE        87-100J   ##########    0 ##############################    0 *  0.00  11.04   0.00
AVN BDE        17-201J      1    0 #####    0 #########################    1 *  1.00 SEE CBT AVN
ACR            17-51J    ####################    1 ####################    1 *  1.00   9.81   9.81
INF BN         7-245J       5    0    0 ##########    0 ###############    5 *  5.00   2.38  11.90
ARMOR BN       17-235J      5    0    0 ###############    0 ##########    5 *  5.00   3.14  15.70
DIV CAV SQN    17-205J      1    0 #####    0 ###############    0 #####    1 *  1.00   1.40   1.40
REGT CAV SQN   17-55J    ####################    3 ###############    0    3 *  3.00   3.27   9.81
                                                               US MVR TOTAL:  38.81
                         LID  AASLT ABN LID  AASLT ABN LID  AASLT ABN TOTAL*COMBAT UNIT   CURRENT
                         DIV  DIV   DIV BN   BN    BN  CAB  CAB   CAB TYPE *EFFECT COMBAT COMBAT
               ATTRIT:   1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 UNIT *TOTAL  POWER  POWER
LIGHT INF DIV  77-L         0 ########################################    0 *  0.00   9.00   0.00
AIRMOBILE DIV  67-L      #####    0 ###################################    0 *  0.00  13.50   0.00
AIRBORNE DIV   57-L      ##########    0 ##############################    0 *  0.00  13.50   0.00
LID BN         7-15L        0 ##########    0 #########################    0 *  0.00   1.00   0.00
AASLT BN       7-55L     #####    0 ##########    0 ####################    0 *  0.00   1.50   0.00
ABN BN         7-35L     ##########    0 ##########    0 ###############    0 *  0.00   1.50   0.00
LID CAB        1-100L       0 #########################    0 ##########    0 *  0.00 SEE CBT AVN
LID RECON BN   17-185L      0 ########################################    0 *  0.00 SEE CBT AVN
AASLT CAB      1-200L    #####    0 #########################    0 #####    0 *  0.00 SEE CBT AVN
AIR RCON SQN   1-265L    #####    0 ###################################    0 *  0.00 SEE CBT AVN
ABN CAB        1-70L     ##########    0 #########################    0    0 *  0.00 SEE CBT AVN
AIR RECON SQN  1-75L     ##########    0 ##############################    0 *  0.00 SEE CBT AVN
                                                                              0.00
                              US ARTILLERY UNITS
                                (ATTRITION FACTOR)
                         DIV  DIV  DIV   DIV  155  203 MLRS MLRS 105mmTOTAL*COMBAT UNIT   CURRENT
                         ARTY ARTY ARTY ARTY BN    BN   BN  BTRY TWD  TYPE *EFFECT COMBAT COMBAT
                         HVY  LID  AASLT ABN SP    SP                 UNIT *TOTAL  POWER  POWER
               ATTRIT:   1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00      *               0.00
DIVARTY (HVY)  6-200J       1 ########################################    1 *  1.00  12.80  12.80
DIVARTY (LID)  5-100L    #####    0 ###################################    0 *  0.00   6.00   0.00
DIVARTY (AASLT) 6-700L   ##########    0 ##############################    0 *  0.00   6.00   0.00
DIVARTY (ABN)  6-200L    ###############    0 #########################    0 *  0.00   6.00   0.00
155 BN SP      6-307J       3 ###############    3 ####################    6 *  6.00   3.60  21.60
203 BN SP      6-447J    #########################    2 ###############    2 *  2.00   3.00   6.00
MLRS BN        6-525J    ##############################    1 ##########    1 *  1.00   6.00   6.00
MLRS BTRY      6-398J       1 #########################    3    0 #####    4 *  4.00   2.00   8.00
105MM BN TWD             #####    0    0    0 ####################    0    0 *  0.00   2.00   0.00
                                                              *US ARTY TOTAL: 35.60

                              US CBT AVIATION
                              (ATTRITION FACTOR)
                         CAB  CAB  CAB   CAB CAB  CAB  ATK  ATK  ACR
                         HVY  LID  AASLT ABN HVY  CONT BN   BN   AVN  TOTAL*COMBAT UNIT   CURRENT
                         DIV                 CORP CORP AH64 AH1S SQN  TYPE *EFFECT COMBAT COMBAT
               ATTRIT:   1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 UNIT *TOTAL  POWER  POWER
CAB (HVY)      17-201J      1 ########################################    1 *  1.00  18.00  18.00
CAB (LID)      1-100L    #####    0 ###################################    0 *  0.00   9.00   0.00
```

Inclosure 1-3, APP D: FASTCALC Correlation of Forces Report

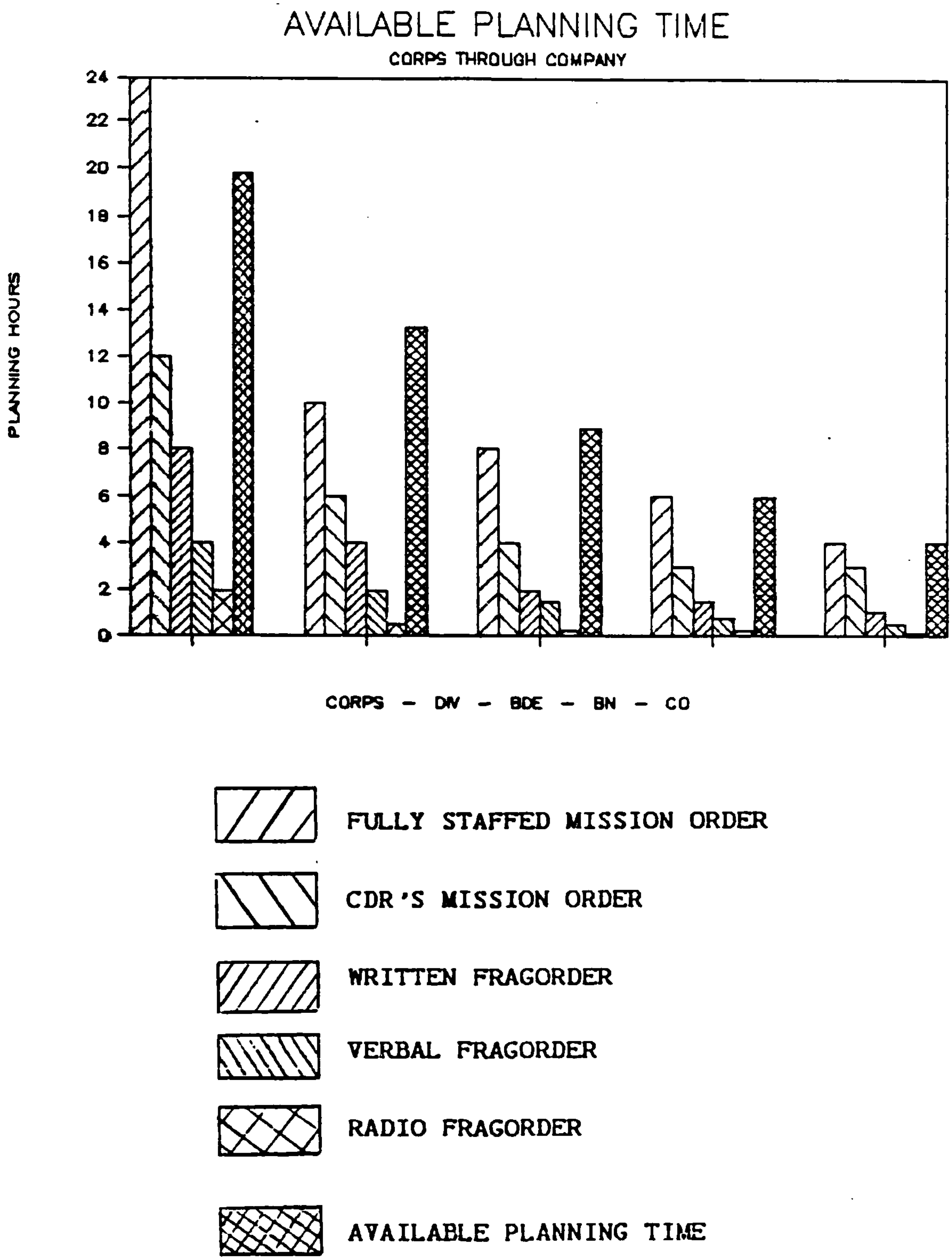
```
CAB (AASLT)       1-200L  **********    0 ******************************    0 *  0.00  28.50   0.00
CAB (ABN)         1-70L   ***************    0 *************************    0 *  0.00  10.50   0.00
CAB (HVY CORPS)   1-400L  ********************    0 ********************    0 *  0.00  40.50   0.00
CAB (CONT CORPS)  1-400L  *************************    0 ***************    0 *  0.00  51.00   0.00
ATK HEL GP (AH64)         ********************    0    0 ***************    0 *  0.00  22.00   0.00
ATK HEL GP (AH1S)         ********************    0 ********************    0 *  0.00  19.00   0.00
ATK HEL BN (AH64)1-385       2 *****    0 *****    0    0    0 **********   2 *  2.00   7.50  15.00
ATK HEL BN (AH1S)         *****    0    0    0    0 **********    0 *****   0 *  0.00   6.00   0.00
AIR CAV SQN               **********    0    0 *****    0 **********    1   1 *  1.00   8.50   8.50
AIR TROOP (AH1S)             2    0 *****    0 *****    0 **********    3   5 *  5.00   1.50   7.50
ATK HEL CO (AH64)            6 *****    0 *****    0    0    0 **********   6 *  6.00   2.50  15.00
ATK HEL CO (AH1S)         *****    0    0    0    0 **********    0    2   2 *  2.00   2.00   4.00
                                                                             US CBT AVN TOT 26.50

                          ************************************************************************
                                                          CBT
                                                         RATIO
                                              US   SOV   US:SOV
Concept by:                           MANEUVER: 38.8 48.5   1  :  1.24
     Major David A. Fastabend         CBT AVN:  26.5 47.8   1  :  1.80
     82 3rd Infantry Road             ARTILLERY:35.6 73.4   1  :  2.06
     Fort Leavenworth, KS, 66027
     913-651-0356
```

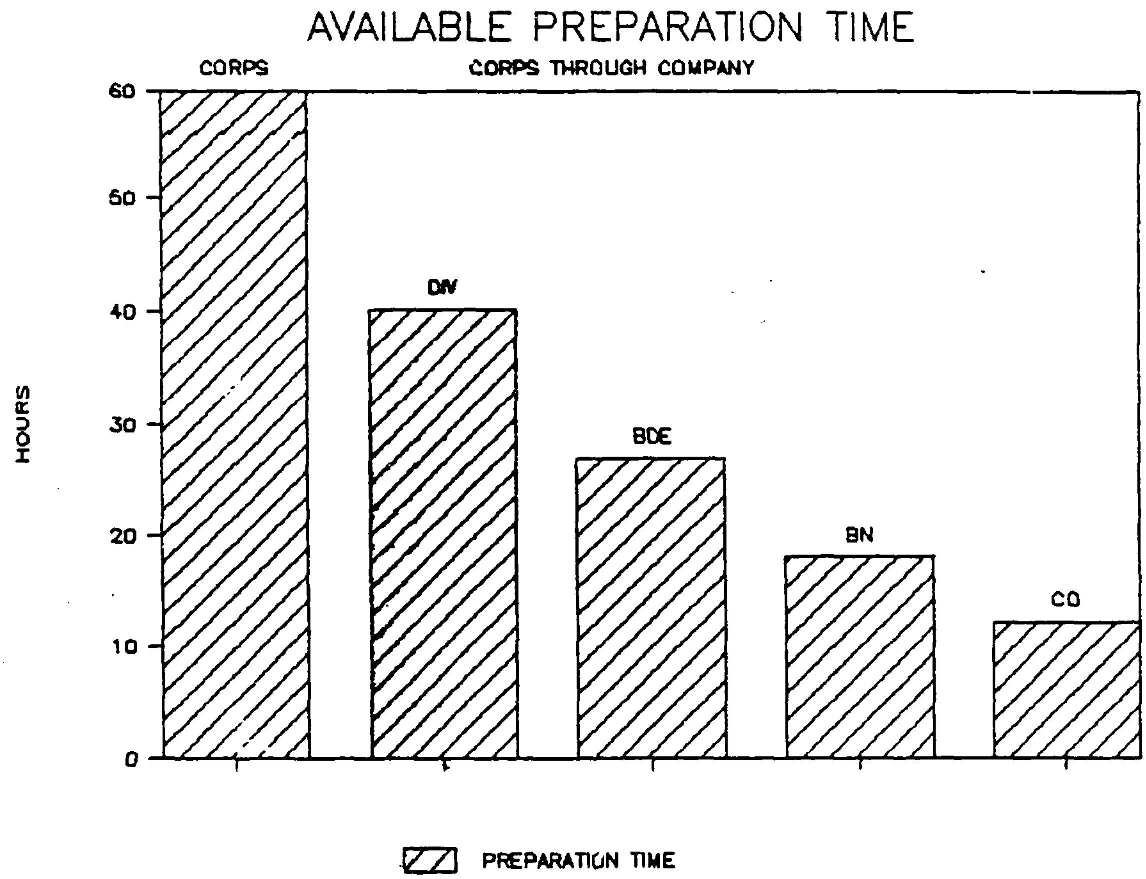
Inclosure 2-1, APP D: Sample FASTPLAN Screen Image

```
             A                   D       E   F G                   AH        AIAJAKALAM
1   UNIT LEVEL:                CORPS         !   1                            C
2   % PLANNING TIME             33.00%       !   2                            O D B
3                               DATE    TIME !   3                            R I D B C
4     WARNING NOTICE IN                      !   4                            P V E N O
5    MISSION START TIME 14-Jul-87 12   0     !   5                            S
6   PLANNING START TIME 12-Jul-87  0   0     !   6  ORDER (STAFF)               * *
7                                            !   7  ORDER (CDR)               * * * * *
8      PREPARATION TIME     60.00 HRS        !   8  WRITTEN FRAGORDER* * * * *
9         PLANNING TIME     19.80 HRS        !   9  VERBAL FRAGORDER * * * * *
10                                           !   10 RADIO ORDER              * * * * *
11  PLANNING SCHEDULE:                       !   11
12     MISSION ANALYSIS 12-Jul-87  1 59      !   12 Concept by:
13        CDRS GUIDANCE                      !   13 MAJ David A. Fastabend
14   WARNING NOTICE OUT 12-Jul-87  3 58      !   14 82 3d Infantry Road
15                FACTS                      !   15 Fort Leavenworth, KS, 66027
16          ASSUMPTIONS                      !   16 #913-651-0356
17           DEDUCTIONS                      !   17
18  ANALYSIS & DECISION 12-Jul-87 15 50      !   18
19        WARNING ORDER 12-Jul-87 19 48      !   19
20         FORMAL ORDER                      !   20
06-Oct-87  11:42 PM
```

Inclosure 2-2, APP D: Decision Graphic, Minimum Planning Time Estimate vs Available Planning Time



Inclosure 2-3, APP D: Decision Graphic, Available Preparation Times



Inclosure 2-4, APP D: Planning Schedule Report

| UNIT LEVEL: | CORPS | DIVISION | BRIGADE | BATTALION | COMPANY |
|---|---|---|---|---|---|
| % PLANNING TIME | 33.00% | 33.00% | 33.00% | 33.00% | 33.00% |
| | DATE TIME | DATE TIME | DATE TIME | DATE TIME | DATE TIME |
| WARNING NOTICE IN | | 12-Jul-87 3 58 | 12-Jul-87 22 27 | 13-Jul-87 10 51 | 13-Jul-87 19 9 |
| MISSION START TIME | 14-Jul-87 12 0 | 14-Jul-87 12 0 | 14-Jul-87 12 0 | 14-Jul-87 12 0 | 14-Jul-87 12 0 |
| PLANNING START TIME | 12-Jul-87 0 0 | 12-Jul-87 19 48 | 13-Jul-87 9 3. | 13-Jul-87 17 57 | 13-Jul-87 23 54 |
| | | | | | |
| PREPARATION TIME | 60.00 HRS | 40.20 HRS | 26.93 HRS | 18.05 HRS | 12.09 HRS |
| PLANNING TIME | 19.80 HRS | 13.27 HRS | 8.89 HRS | 5.96 HRS | 3.99 HRS |
| | | | | | |
| PLANNING SCHEDULE: | | | | | |
| MISSION ANALYSIS | 0.10 12-Jul-87 1 59 | 0.10 12-Jul-87 21 8 | 0.10 13-Jul-87 9 57 | 0.10 13-Jul-87 18 33 | 0.10 13-Jul-87 0 18 |
| CDRS GUIDANCE | | | | | |
| WARNING NOTICE OUT | 0.20 12-Jul-87 3 58 | 0.20 12-Jul-87 22 27 | 0.20 13-Jul-87 10 51 | 0.20 13-Jul-87 19 9 | 0.20 13-Jul-87 0 42 |
| FACTS | | | | | |
| ASSUMPTIONS | | | | | |
| DEDUCTIONS | | | | | |
| ANALYSIS & DECISION | 0.80 12-Jul-87 15 50 | 0.80 13-Jul-87 6 25 | 0.80 13-Jul-87 16 11 | 0.80 13-Jul-87 22 43 | 0.80 13-Jul-87 3 6 |
| WARNING ORDER | 1.00 12-Jul-87 19 48 | 1.00 13-Jul-87 9 4 | 1.00 13-Jul-87 17 57 | 1.00 13-Jul-87 23 55 | 1.00 14-Jul-87 3 54 |
| FORMAL ORDER | | | | | |
| MIN PLANNING TIMES: | | | | | |
| ORDER (STAFF) | 24 | 10 | 8 | 6 | 4 |
| ORDER (CDR) | 12 | 6 | 4 | 3 | 3 |
| WRITTEN FRAGORDER | 8 | 4 | 2 | 1.5 | 1 |
| VERBAL FRAGORDER | 4 | 2 | 1.5 | 0.75 | 0.5 |
| RADIO FRAGORDER | 2 | 0.5 | 0.25 | 0.25 | 0.1 |

Inclosure 3-1, APP D: FASTMOVE1: Time Required for the Advancement of a Subunit from one Region to Another

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | | TIME REQUIRED FOR THE ADVANCEMENT OF A | | | | | | |
| 2 | | SUBUNIT FROM ONE REGION TO ANOTHER | | | | | | |
| 3 | | | | | | | | |
| 4 | | T = D/V + Ts + Te | | | | | | |
| 5 | | | | | | | | |
| 6 | | INPUT | OUTPUT | UNITS | DEFINITION | | | |
| 7 | T | | 26.00 | HOURS | MARCHING TIME | | | |
| 8 | D | 280 | | KM | ROUTE LENGTH | | | |
| 9 | V | 20 | | KM/HOUR | AVERAGE TRAVEL SPEED OF ROUTE COLUMN | | | |
| 10 | Ts | 9 | | HOURS | TOTAL STOPPING TIME DURING THE TRAVEL | | | |
| 11 | Te | 3 | | HOURS | TIME TO DEPLOY IN NEW CONCENTRATION REGION | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |

09-Oct-87 10:03 PM

Inclosure 3-2, APP D: FASTMOVE2: Entry Time of a Route Column to Arrive at a Designated Point

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | | ENTRY TIME OF A ROUTE COLUMN TO THE INITIAL LINE (POINT) | | | | | | |
| 2 | | USED TO DETERMINE TIME FOR SIMULTANEOUS ARRIVAL AT LD OR SP | | | | | | |
| 3 | | | | | | | | |
| 4 | | Tb = T - ((Di))/(Vp) | | | | | | |
| 5 | | | | | | | | |
| 6 | | INPUT | OUTPUT | UNITS | | DEFINITION | | |
| 7 | Tb | | 19.33 | TIME | TRAVEL START TIME OF COLUMN | | | |
| 8 | T | 22 | | TIME | TIME OF PASSAGE AT TGT POINT (LINE) BY | | | |
| 9 | | | | | HEAD OF ROUTE COLUMN | | | |
| 10 | Di | 40 | | KM | DISTANCE FROM START POINT TO TARGET POINT | | | |
| 11 | Vp | 15 | | KM/HR | TRAVEL SPEED OF THE ROUTE COLUMN | | | |
| 12 | | | | | | | | |
| 13 | | | | | TIMES ARE IN DECIMAL FRACTIONS OF HOURS | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |

09-Oct-87 10:02 PM

Inclosure 3-3, APP D: FASTMOVE3: Concentration Time

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | | PASSAGE TIME OF A ROUTE COLUMN INTO A CONCENTRATION REGION | | | | | | |
| 2 | | (USED WHEN THE DEPTH OF THE REGION IS LESS THAN THE DEPTH | | | | | | |
| 3 | | OF THE MARCH ROUTE) | | | | | | |
| 4 | | | | | | | | |
| 5 | | Tcon = (Dc -Dr)/Vp X 60 | | | | | | |
| 6 | | | | | | | | |
| 7 | | INPUT | OUTPUT | UNITS | DEFINITION | | | |
| 8 | Tcon | | 30.00 | MIN | TIME TO DEPLOY INTO CONCENTRATION REGION | | | |
| 9 | Dc | 7 | | KM | DEPTH OF THE ROUTE COLUMN | | | |
| 10 | Dr | 2 | | KM | DEPTH OF THE CONCENTRATION REGION | | | |
| 11 | Vp | 10 | | KM/HR | TRAVEL SPEED OF COLUMN | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |

09-Oct-87 10:00 PM

Inclosure 3-4, APP D: FASTMOVE4: Rail Transportation Time

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | TIME FOR TRANSPORTING UNITS BY RAIL | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | T =((D/V)+((N-1)/n))*24 + D1/V1 + D2/V2 + Tl + Tu +To | | | | | | | |
| 5 | | | | | | | | |
| 6 | | INPUT | OUTPUT | UNITS | DEFINITION | | | |
| 7 | T | | 32.03 | HOURS | TIME FOR TRANSPORTING TROOPS BY RAIL | | | |
| 8 | D | 300 | | KM | LENGTH OF RAILROAD ROUTE | | | |
| 9 | V | 720 | | KM/DAY | AVERAGE DAILY RATE OF MOVEMENT OF TRAINS | | | |
| 10 | N | 12 | | # | NUMBER OF TRAINS | | | |
| 11 | n | 87 | | # | RATE OF TRANSPORT IN TRAINS PER DAY | | | |
| 12 | D1 | 15 | | KM | DISTANCE FROM START AREA TO LOADING AREA | | | |
| 13 | V1 | 10 | | KM/HR | AVERAGE RATE OF MOVEMENT TO LOADING AREA | | | |
| 14 | D2 | 15 | | KM | DISTANCE FROM UNLOADING AREA TO NEW CONCEN | | | |
| 15 | V2 | 10 | | KM/HR | AVERAGE RATE OF MOVEMENT TO THE NEW AREA | | | |
| 16 | Tl | 7 | | HRS | LOADING TIME | | | |
| 17 | Tu | 7 | | HRS | UNLOADING TIME | | | |
| 18 | To | 2 | | HRS | TIME FOR ORGANIZING TRANSPORT | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |

09-Oct-87 09:59 PM

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21. Romjue, op cit, p 51.

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36. R. Portugal'skiy, Command Procedures in the Great Patriotic War, JPRS 66636, 21 January 1976, p 42.

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42. One of the most common misperceptions among American officers is that Soviet planners neglect the human element of the decision making process. Soviet writings that contradict this view abound. The following quote, presented by C. N. Donnelly in a 13 Oct 87 lecture at the US Army Command and General Staff College School of Advanced Military Studies, is illustrative:

D. Yakelovich:

"The first step is to model whatever can be measured. This is okay as far as it goes.

The second step is either to disregard that which cannot be measured or to give it an arbitrary value. This is artificial and misleading.

The third step is to assume that what cannot be measured easily is not important. This is blindness.

The fourth step is to say that what cannot be easily measured really does not exist. This is suicide."

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52. V. Abchuk, "Commander Makes a Decision", Krasnaya Zveda, 20 September 1974, p 4.

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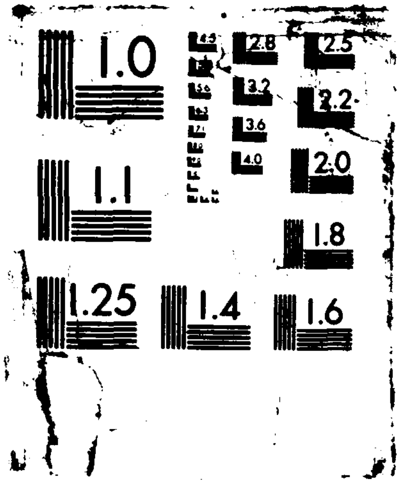
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